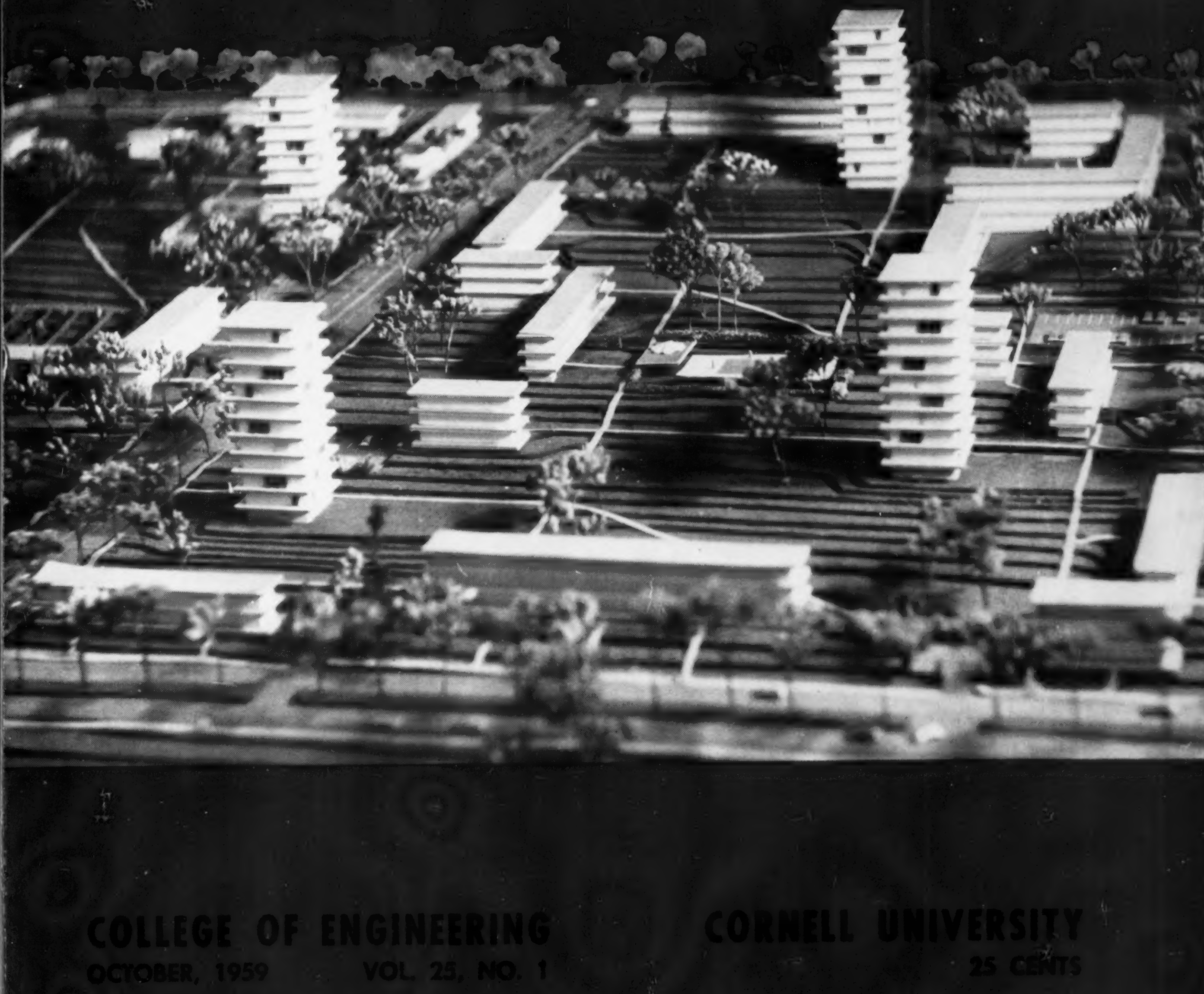
the Cornell engineer



COLLEGE OF ENGINEERING

CORNELL UNIVERSITY

OCTOBER, 1959 VOL. 25, NO. 1

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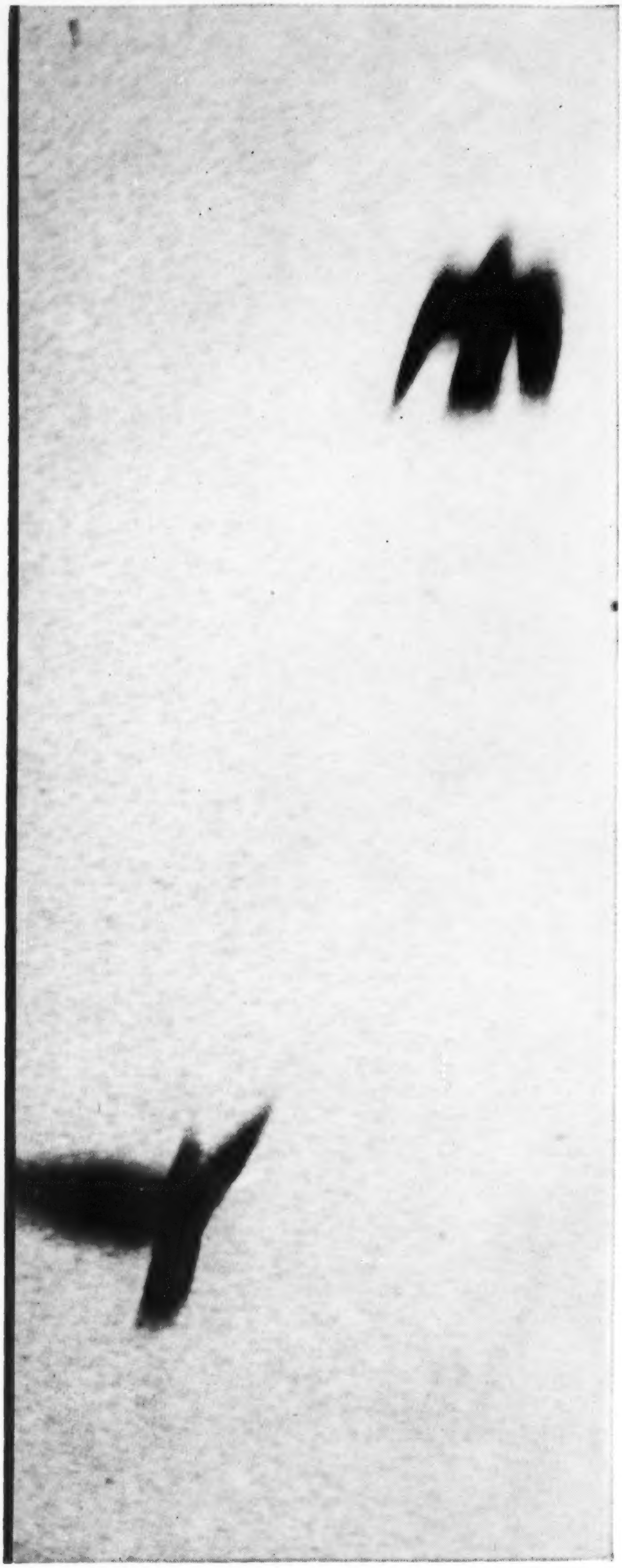

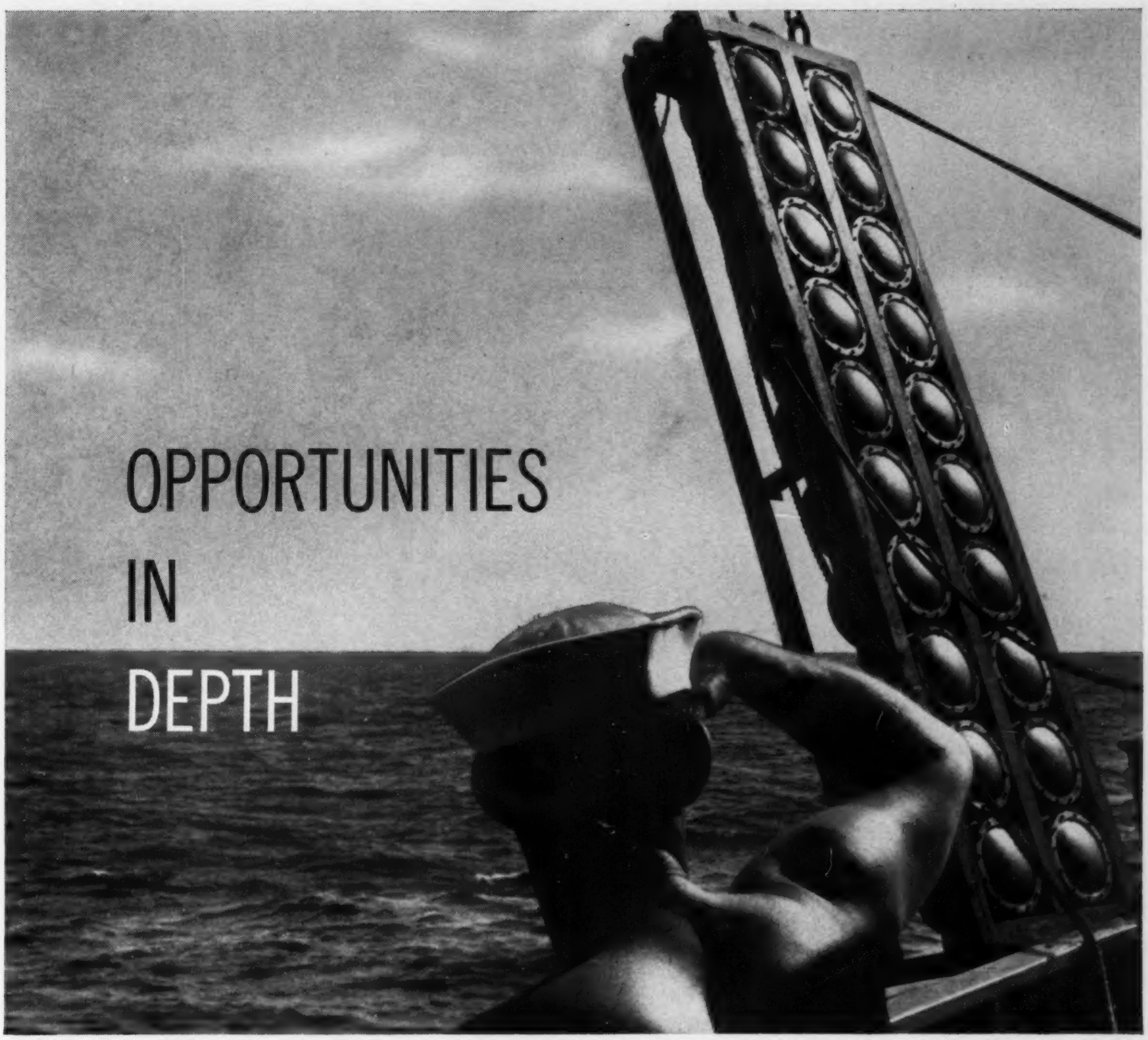

The device about to be submerged is an "underwater sound source". It transmits sound waves beneath the sea and is part of the research equipment developed by Bendix Research Laboratories Division for use in the Bendix program of undersea acoustics research.

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Thorstein Veblen...on the place of science

"In creative art, as well as in critical taste, the faltering talent of Christendom can at the best follow the lead of the ancient Greeks and the Chinese. In myth-making, folklore, and occult symbolism many of the lower barbarians have achieved things beyond what the latter-day priests and poets know how to propose. In political finesse, as well as in unreasoning, brute loyalty, more than one of the ancient peoples give evidence of a capacity to which no modern civilized nation may aspire.

"To modern civilized men, especially in their intervals of sober reflection, all these things that distinguish the barbarian civilizations seem of dubious value... futile in comparison with the achievements of science. They dwindle in men's esteem as time passes. This is the one secure holding-ground of latter-day conviction, that 'the increase and diffusion of knowledge among men' is indefeasibly right and good. When seen in such perspective as will clear it of the trivial perplexities of work day life, this proposition is not questioned within the horizon of western culture, and no other cultural ideal holds a similar unquestioned place in the convictions of civilized mankind."

—The Place of Science in Modern Civilization, 1906

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Advisor Retires

Professor Edwin B. Watson

Professor Edwin B. Watson, faculty advisor of the CORNELL ENGINEER, has recently accepted a position as chief engineer of the diesel injection department of the Bendix Aviation Corporation. His resignation from the ENGINEER marks the termination of a more than two-year advisorship. During that time his help and advice have been major factors in the magazine's development. Last year he was elected to the vice-presidency of ECMA.

Student affairs have been one of Professor Watson's major interests. We have always found him available for advice on ENGINEER or personal problems. This interest in student affairs is further evidenced by his advisorships to Tau Beta Pi and Pi Tau Sigma. His other campus activities include the Willard Straight Board of Governors and Board of Managers, the Economic Status Committee, the Cornell National Scholarship Committee, and the Policy Committee of the engineering faculty.

Active in community affairs, Professor Watson is a member of the Town of Ithaca Planning Board, the Greater Ithaca Regional Planning Board, and the City Club of Ithaca.

Professor Watson joined the Cornell faculty in 1943. He became an associate professor in 1947 in the department of thermal engineering. He is a member of Phi Beta Kappa, Tau Beta Pi, Pi Tau Sigma, the Society of Automotive Engineers and the ASME. —A.S.R.

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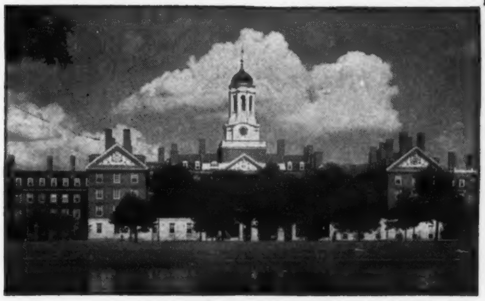

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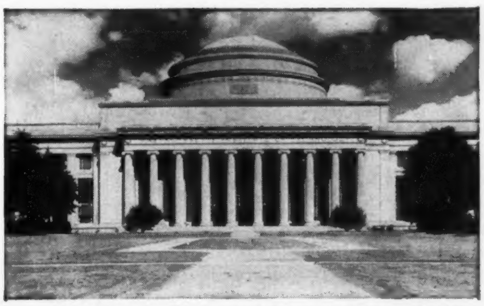

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Editorials:

ACTIVITIES AND THE "ENGINEER"

September 23 marked the beginning of classes, but one phase of Cornell life has been busily humming for some time prior to registration. The student activities program that we now see functioning represents a good deal of summer preparation. The athletics program, the special interest groups, the religious organizations, and the campus publications have all had their share of vacation work. We on the *Engineer* can readily testify to the hard work involved in meeting a deadline when the staff is scattered all over the country.

The enthusiasm with which students work on these different organizations clearly testifies to the enjoyment derived from them. But another aspect of this program should be considered.

To you as Cornell engineers, the activities program is particularly important. Here is a chance to get away from the books and explore new fields of interest, meet people, and gain new skills. Enough emphasis cannot be placed on the importance of participating in Cornell's non-academic as well as its academic areas.

As a student organization, the *Cornell Engineer* offers such an opportunity. Here you can combine your technical with your non-technical interests.

One of the top engineering college magazines in the country, the *Engineer* provides you with an opportunity to keep abreast of news in the engineering school by interviewing, photographing, and meeting professors, alumni, and upperclassmen.

Competitions for the magazine are open to all undergraduates. All students will get an overall view of magazine publishing techniques as well as intensive training in illustrations, business, or editorial operations. The experience gained in these training programs has repeatedly demonstrated its value in a large number of areas.

Competitions will continue to be open throughout the fall term. Interested students are invited to sign a list outside the office at 1 Carpenter Hall.—A.S.R.

THANKS TO THE SOCIETY

The *Cornell Engineer* and the Cornell Society of Engineers have had a long association. For as long as we can remember, we have reserved a section of the magazine for this fine organization. We look forward with pleasure to the possibility of enlarging this portion of the magazine, not only because of the large segment of our subscribers who belong to the Society, but also because of its outstanding work for the College of Engineering.

The Society does a remarkable job of keeping Cornell alumni engineers together. To this end we understand that a new alumni directory is soon to be published largely through the efforts of society members.

This group, however, does not function for the benefit of the alumni alone. Its basic concern is with the College of Engineering—its present and future.

The Society has always been a leader in Cornell fund raising activities. Their efforts in this direction are evident in the new quadrangle.

Another one of their noteworthy projects is the Engineers' Day program. The Society has been one of the chief backers of this exhibit.

Its work with the sub-frosh deserves particular commendation. Members of the Society all over the country are actively engaged in explaining Cornell's engineering program to high school students. Through their efforts many students are able to evaluate their engineering aptitudes better and decide upon the right college. We were grateful for an opportunity to attend a sub-frosh orientation sponsored by the Society last spring. At this meeting prospective Cornell engineers had a chance to meet engineering alumni, professors, and students on an informal basis. The large attendance at this meeting is certainly one indication of its successfulness. We hope that future years will see these meetings expanded to include student as well as faculty and alumni speakers.

This is the time of the year for alumni to show their support of this important organization. We urge you to join the Society now. It is an effective way for you to show your continued interest in Cornell's College of Engineering.—A.S.R.

Founded in 1885

THE CORNELL

engineer

OCTOBER 1959 VOLUME 25 NO. 1

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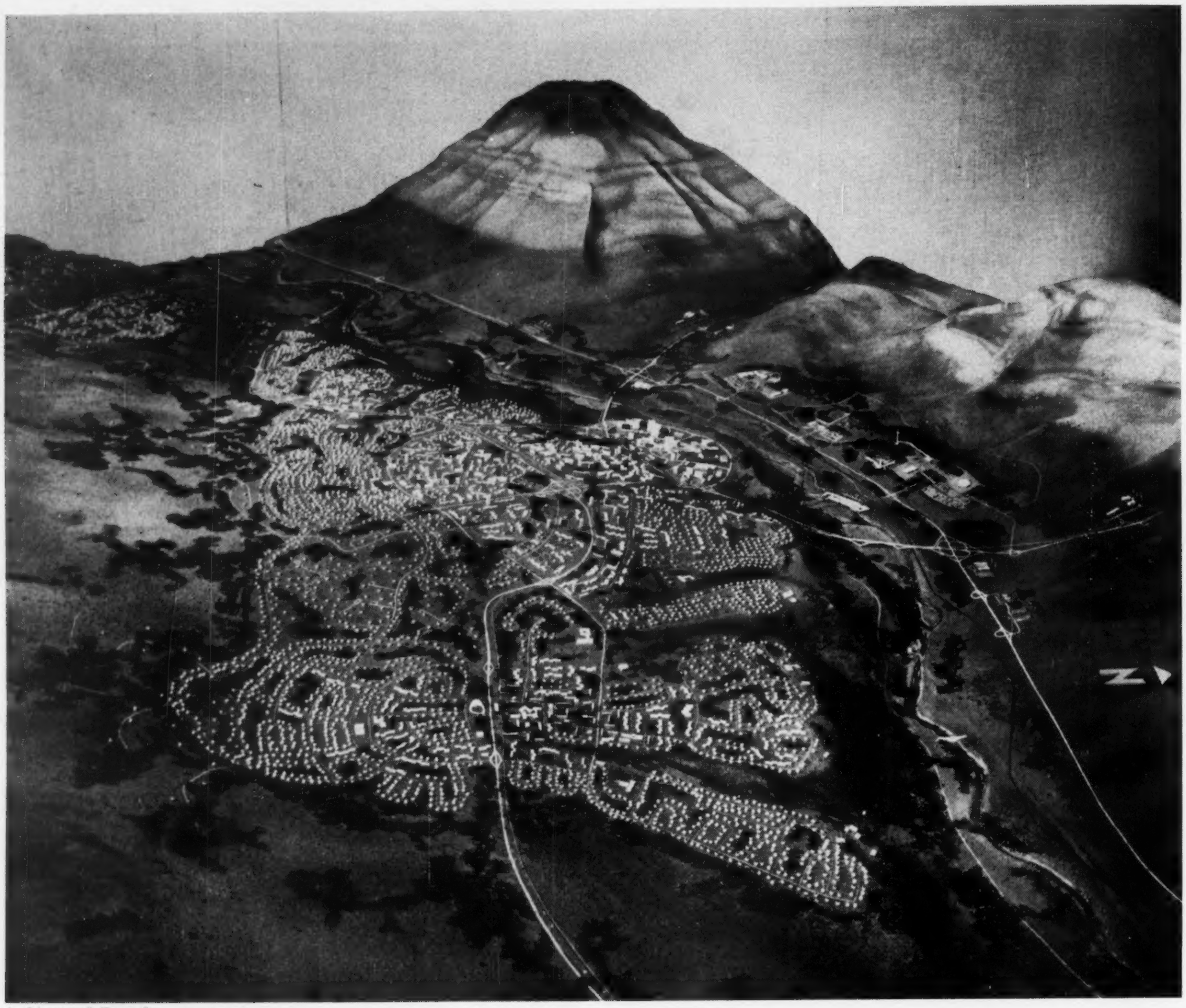


Architectural Record

This is Grand Valley, Colorado, conceived and designed in the grand tradition of man's inventive genius, and dedicated to his future. This view of Cornell's model of the city shows one of the major complexes in the design. The view is toward the west along the Colorado River valley.

City and Regional Planning Students Design . . .

A CITY FOR AN INDUSTRY

by Ted Jones, Arch. '63

Oil! This fantastically necessary stuff which built our modern world is doing some more building. Last fall the graduate City and Regional Planning Department of Cornell's College of Architecture designed a complete new city. "Grand Valley," as it is called at present, will center around the now infant, but sure to grow, shale oil industry.

Located on the western slopes of Colorado's Rocky Mountains in the Colorado River valley, Grand Valley will lie between the now-existing towns of Rifle and De Beque, covering ground now occupied by Lacy, Morris, Rulison, Uma, and Grand Valley. The proposed design will support a population in the neighborhood of 350,000 people, making it larger than either Salt Lake City or Omaha.

Oil from Rock

For some time now scientists have known that a certain area known as the Green River Formation, covering territory in Colorado, Wyoming, and Utah, was rich in marlstone. This rocky substance contains solid organic material deposited by marine life ages ago when immense salt seas covered much of the western part of this country. The material, called kerogen, can be distilled from crushed oil shale and drawn off as a thick liquid comparable to crude petroleum. For some purposes this distillate is even better than regular petroleum. It has been estimated that the amount of shale oil present in the Grand Valley region is in excess of one and one-half trillion barrels—enough oil to fill the needs of this country for 300 years!

A goodly portion of this oil-rich land is owned by the Navy and forms an extensive part of its oil reserves. Should the western world ever lose control of the oil resources of the Middle East, the Green River Formation would become our major remaining source of oil. Ever since World War II both the government and the petroleum industry have shown great interest in developing processes for exploiting this immense storehouse of energy. The major hurdle has been the relatively great expense of extracting the oil from the shale, as compared with the present cost of obtaining natural crude oil. A pioneer in the effort to overcome this high cost was the Union Oil Company of California, in conjunction with the National Bureau of Mines. Another company working in the field, the Oil Shale Development Corporation, together with the Denver Research Institute, experimented with a process developed by the Swedish chemist Olaf Aspergren.

A third process, possibly the one that will be used, involves exploding a small nuclear bomb hundreds of feet beneath the ground level. The blast not only "mines" the material but also converts it into liquid form right there so that it can be pumped out like natural oil! Tests of this radical new method, approved by the Atomic Energy Commission, will cost about two and one-half million dollars, half to be contributed by the government, half by industry.

Planners' Role

A huge industrial complex of the size possible with the development of the oil shale deposits of Colorado cannot run all by itself. It requires men—and lots of them. Over 100,000 workers would eventually be required to keep the industry producing at its ultimate planned capacity. And men must live and maintain their families somewhere. They must have transportation and communication systems, water and electricity. They must have hospitals, schools, and churches—banks, bakeries, and gas stations. They must have places in which to play as well as in which to work. All this must be provided before men can, or will, settle down to stay in a place. And that's where the Cornell planners come in.

The planners, who were the first group to present a solution to the problem of Grand Valley, had several reasons for undertaking such a project. The main objective was to provide a thorough means of introducing new students to the problems faced by a city planner. By participating in such a program, the student becomes familiar with every aspect of the whole operation and is better prepared for later work. Another aim was to educate the general public in the great advantages of organized city planning. Coupled with this was the desire to stimulate civic thought in the Grand Valley area about the region's future and the need for developing some plan of organized growth for it.

Naturally, any educational project with such sizable goals has to have leadership of comparable magnitude. This was ably furnished by the faculty staff, headed by Associate Professor Frederick W. Edmondson, Jr., and including Assistant Professor Robert D. Katz and Graduate Assistant R. Jackson Seay, Jr., of the Department of City Planning.

Professor Edmondson was the one to set the ball rolling. At the beginning of the summer of 1958, he traveled to Colorado and began to criss-cross the entire region under consideration as site for the

proposed city, an area of about nine hundred square miles. Proceeding in whatever ways the terrain dictated—by plane, canoe, horseback, or on foot, to mention a few—Prof. Edmondson gathered every kind of information about the terrain. This included soil data, topographical and biological information, and notes on the minerals in the area. All of this, including slides, was brought back to Cornell at the end of the summer, combined with similar material from outside sources, and catalogued and filed for the use of the students.

As soon as the fall term began, the thirty-four students in the group were introduced to the program with the aid of Prof. Edmondson's slides. They were quickly divided into small teams, each of which studied a different aspect of the site, including such matters as climate, geography, geology, and the present status of the area with respect to utilities, population, transportation and communication. Since all of these factors, plus many others, were important to the design of the new city, each team prepared a report for presentation to the entire class, so that everyone would be fully acquainted with the area.

By this time, the students had familiarized themselves with all the elements of the oil shale industry itself. The types of people to be employed in the industry and the people who would work in the attending auxiliary industries and supporting services necessary to the community were studied.

The next phase of the work was to map the entire area through air photo reconaissance and analysis. U.S. Geological surveys were also used. The air photo "mission" was accomplished with the aid of Architecture Assistant Professor Maurice Perreault, along with several Naval Reserve Pilots from Buffalo, New York. Through complete interpretive analysis, the planners supplemented the material they already possessed with information about soils, sub-soils, slopes, and drainage. When this operation was finished, each planner knew every nook and cranny of those nine hundred square miles as well as he knew his own back yard.

Designing Begins

Now the actual business of designing began. Three larger teams were formed, each developing a preliminary regional plan for the whole area, providing for every detail necessary to the final plan. These were presented to the class for discussion and criticism. As all three teams had selected practically identical sites for the city, although they had worked independently with an almost competitive secretiveness, not much discussion was necessary to determine the exact location for the final design. Along with a regional plan, each team also presented supplementary material. Utility and transportation plans were developed. Other information included land-use plans, indicating the placement of the various elements of the city—e.g., heavy industry and residential and commercial districts—and stage-of-development plans, which provided for an organized growth of the city as more and more people arrive.

At this point a final regional planning team combined the best parts of each of the three preliminary proposals, along with new and original thought, into the existing regional design. The rest of the class assisted, covering the minor details within the design. Again, utilities and transportation were given special treatment. There were also special teams to design a monorail system to be used throughout the city, to do detailed research on housing, on a central business district, on parks, and on the possible use of atomic energy. Even a special graphics team was provided to prepare the proposals of the other teams for final presentation. This last major effort consisted of large-scale land-use maps with overlay plans for the specialized details. Accompanying was a huge model of the design (scale: 1 inch = 500 feet).

The Cornellians followed a definite philosophy of design when they planned the Grand Valley project. Not only did they have to provide a city geared, to some extent, to the needs of an industry, but they also had to provide the best and most livable of cities for its people as well. Not only did they try to design progressively, with an eye to the future, but they also aimed at preserving Grand Valley's regional aura—that pioneering, Western flavor inherent in the character and traditions of the place. Physically, this meant as little bull-dozing and grading as possible, so that the present topography might be retained. The characteristically fan-shaped mesas and roan cliffs along the valley were to be allowed to provide a natural backdrop to help retain the desired touch.

The city itself is designed in linear form, long and narrow, stretching thirty miles from Rifle

Photo Science

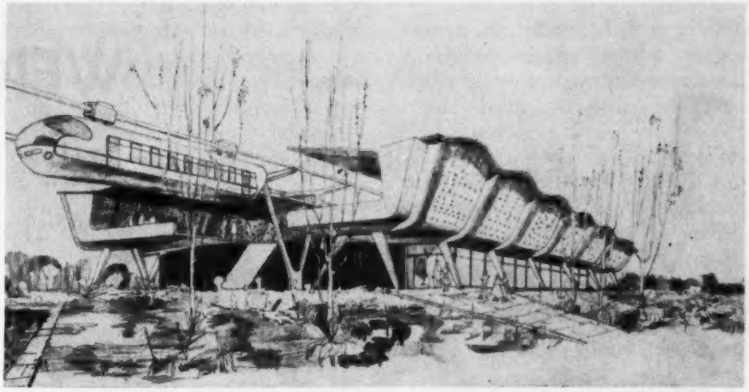
Cornell city planners struggle over the minutely detailed model vital to the successful presentation of their ideas for Grand Valley.

to De Beque. The reasons for this are the mountains on one side and the mesas on the other. These naturally restrict the city's lateral growth and permit it to expand only lengthwise along the river valley. The river acts as a natural boundary down the middle of the valley and is used to separate industrial complexes from the rest of the city. In the design, these are located on the northern side of the river, with their huge retorts situated in branch canyons or ravines that jut back into the mountains. Not only does this place the industry near the source of the raw material, but it also locates it out of sight of the residential and commercial sections of the city. This frees the city from that unsightly industrial blight which affects many communities founded on heavy industry. Any light industry which comes along can be designed into attractively landscaped industrial parks at various locations along the river.

The remainder of the city lies along the southern bank of the river. Two main civic centers are provided—one for a cultural center, another for a governmental complex. Small branch offices of these, such as post offices, are located at various intervals throughout the residential neighborhoods. A central commercial center has been incorporated into the design in like manner, with numerous smaller shopping centers again "scattered" throughout the rest of the city.

Housing has been provided in many forms, varying so that any person can live well in line with his tastes and his pocketbook. Thus everything from apartments to small individual dwellings to large ranch-type designs can be found. These are all situated in individual, self-contained residential neighborhoods, which, nevertheless, are readily accessible to one another. Schools, hospitals, and churches are strategically located either within or at the "junctions" of these neighborhoods.

Water supply, a major problem in this region, is designed in a three-stage development plan to grow with the population. Reservoirs are used extensively throughout the plan, with much of the water coming from special projects to the north. Some of it, however, comes from the Colorado River, and is treated extensively before use. Another source is industrial and domestic sewage, which is reclaimed, treated, and re-used, bringing about a great saving of cost.



Architectural Record

This monorail system, shown here is a rendering by student designers, is one of the many advanced features of city planning championed by the Cornellians.

While men must have a place to work, provision must also be made for them to play. A great system of recreational parks, covering over 3,500 acres, has been spread throughout the city. Facilities for all types of recreation are to be provided. Neighborhood playgrounds for children, incorporated into the school facilities, are also part of the proposal. There is to be a long park running along the river and over one hundred municipal parks. Five country clubs are to be built, and sites for ski slopes to the south have been selected.

Transportation

One of the first moves in tackling the transportation problem was to expand the existing railroads to meet future needs. Industrial traffic is to be diverted to the northern side of the valley, away from the residential south. An even more important part of the design is the highway network. There are three different types of road planned: the small, residential street, following curves in the terrain and not open to through traffic; wider residential "feeders" to gather all small traffic streams from the neighborhoods and channel them out into the largest and last type, the main thoroughfares, which lead in and out of the heart of the metropolitan area.

The third, and most striking, mode of transportation in the design is the monorail system, used as urban public transportation. Similar to systems already in use in Japan, the monorail is necessary because of the unusual length of the city and because of the extremely rough terrain laced with numerous ravines and natural waterways. The monorail does not touch the ground at any point and therefore is not affected by any ground obstacles, including streets. This feature also frees it from trouble with deep snow and flooding. The right-of-way is landscaped to contribute to the areas it crosses rather than to detract from them. The system can also be used to great advantage to convey workers to the industrial complexes, as personal transportation for everyone would be impractical.

This fabulous city, quite capable of becoming a reality within twenty years, could only have been conceived through a vast organized effort. And this effort is city planning. Through its many projects like Grand Valley, Cornell's city planning department is doing all it can to make the general public aware of this. This year the department, in co-operation with the Office of Civil Defense Mobilization, will establish a prototype of underground installations for a critical industry with adjunct facilities for a supporting population. Fantastic structural and ventilation problems will have to be solved, in addition to most of those faced at Grand Valley. And the answer to these problems? As in Grand Valley, they will be found through city planning.

WEIGHTLESSNESS

by Jean Walrath, ChemE '63

Space has always challenged man, and we are living in an age in which he is meeting that challenge. First, small satellites; then, larger vehicles; ultimately, man himself in space. And one of the phenomena which is being probed in preparation for man's ascent into space is weightlessness.

Most of the information on weightlessness has been gained so far through an ingenious technique of flying an airplane through a calculated arc in which gravity is counterbalanced by the plane's speed, thus achieving actual weightlessness for periods up to forty seconds. These zero gravity flights are conducted about twice a week now at the Wright Air Development Center in Dayton, Ohio. From them much invaluable and probably otherwise inaccessible information has been secured.

One question in the minds of scientists has been whether the first space travelers will suffer from spatial disorientation as a result of their exposure to weightlessness. Scott Crossfield, a test pilot who has flown in more than fifty zero gravity tests, reported that he at first felt "befuddled, disoriented, lost in space," but that these reactions disappeared for the most part after his fifth flight. In other cases, disorientation has resulted in most subjects from attempts to "free float." Disorientation from this cause could be cut to a minimum by seeing that the space passengers are in comfortably restrained positions with extremities resting against solid objects or, if free locomotion around the cabin is necessary, by designing a cabin which indicates floor and ceiling by coloring or other obvious means thus giving spatial orientation to the traveler.

USAF

Movement in free flight is accomplished by gently moving arms or legs in a swimming motion. Each such experiment must be accomplished during the minute or less of zero-gravity flight.

Eating Poses Problem

The problem of eating is one to which serious and thoughtful research must be applied. In the first study ever made on this problem, a study which began in 1956 at the Air Force School of Aviation Medicine, it was found that the greatest difficulties to be overcome in this field were those connected with the swallowing, rather than the digesting, of foods. One can easily visualize that in a zero gravity field where everything, even a fluid, floats in air because there is no weight, swallowing would present a problem, and attempting to drink a fluid from an open container would be quite impossible. Also, swallowing of poorly chewed food particles might lead to aspiration, as these particles might float over the palate.

It will be necessary to design food containers which are capable of storing food for long periods of time and of resisting bacterial contamination and spoilage, and which can be put directly in the mouth. These containers will be used for the storing, heating, and dispensing of both liquid and solid foods.

Digestion is not generally thought to be a great problem for most

people under conditions of weightlessness. Food passage time may be slightly reduced because the time required for the complete digestion of foods is to a certain extent an inverse function of their density, a property which is absent in a zero gravity field, but this would have no great effect on any space travelers.

An adverse effect of weightlessness connected with digestion is the "weightless regurgitation phenomena." During experiments at the Randolph Field Department of Space Medicine, it was found that one third of the subjects tested under weightless conditions suffered from gastrointestinal complaints. Also, when a blow or even pressure was applied to the abdomen, regurgitation would take place, even among those subjects who were not troubled normally by any digestive difficulties. However, this took place usually after the consumption of large quantities of fluids, so by regulation of the amount of fluid in the diet of a space traveler, this problem can be controlled.

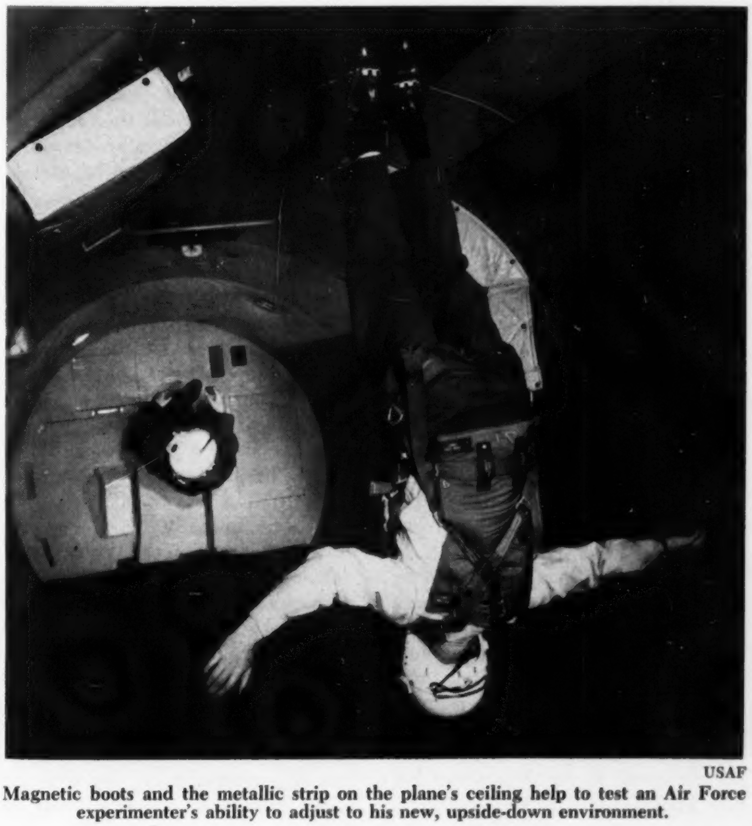
New Ways of Getting Around Needed

In studies made in eye-hand coordination and other types of psychomotor tests, results indicate that man will have no trouble adapting his upper extremities to weightlessness. In the tests conducted so far, his manipulation of the cockpit controls is approximately as fast as under normal conditions. The coordination of the lower extremities will be more difficult to accomplish because of the greater relative weight of the lower extremities. New reflexes and locomotion techniques, such as flinging an arm to turn the body instead of pivoting from a solid footing must be learned. Such devices as slightly magnetized shoes and gloves and non-protuding hand holds in the cabin will probably be used. Also, much attention will be given to pre-flight training in conditions approximating weightlessness, such as water-filled tanks for learning locomotive techniques, or ground based trainers for developing proficiency in manual tasks.

Perhaps one of the most difficult necessities of life to accomplish in outer space will be sleep. Whether deep and restful sleep will be possible without the use of drugs is open to question. Undoubtedly some restraining device which gives "top-bottom" psychological information to the sleeper while permitting him enough movability for comfortable and relaxed sleep will be utilized.

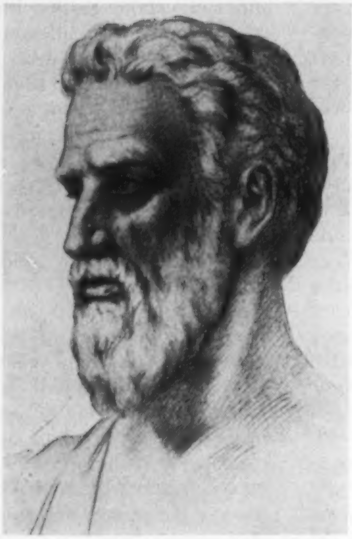
The effect of weightlessness on the circulatory system is not considered to be too great a problem. Scientists learned from the canine passenger of Sputnik II that there is a lag in the return of the pulse rate to normal after the rocket boost. During experiments made by the Navy's Project Stratolab —carried on in part with a plane specially equipped to receive telemetered messages from the heart, blood, and lungs of far-off balloonists—two balloonists were caught in a storm and subjected to sudden plunges which approximated the conditions of outer space. Telemetry data indicated that their hearts beat at more than twice the normal rate and they inhaled and exhaled every second, but they suffered no apparent harm. Experiments have shown that effects such as a slight overfilling of the right heart and shifts of venous pooled blood will result from weightlessness, but that these need cause no concern. All evidence points then to the probability that the circulatory system will not be permanently affected by weightlessness, except possibly in subjects who are returning to earth's acellerative environment after being thoroughly accustomed to life under zero gravitational field.

There are still two attitudes toward the problems of weightlessness. One is that man will never be able to adapt himself fully and adequately to weightlessness; the other, that he can adapt, and might even enjoy it. Before we know the complete answer more research, more experiments, and much more study must be done in this field. As of now the outlook looks hopeful. Man, the most adaptable creature on Earth, will probably find ways to adapt himself to the environment of outer space.



USAF

Magnetic boots and the metallic strip on the plane's ceiling help to test an Air Force experimenter's ability to adjust to his new, upside-down environment.



Brown Brothers

PYTHAGORAS and The Religion of Science

by Jean Biehler, Arts '62

Through the maze of black magic and superstitions that made science in the Sixth Century B.C., in Greece strode a dynamic leader —the brilliant mathematician and religious mystic, Pythagoras. Greece was ready for him. Although the common people understood none of his theories, the more intelligent people in society were fascinated by the magical aspects of numbers and substances. Through the encouragement of Pythagoras the weak stream of mathematical curiosity grew to a major science.

Born an Eastern Greek around 569 B.C., Pythagoras traveled extensively through the Middle East, studying under priests and scribes who taught him Eastern customs and knowledge. The mathematics he absorbed, especially the numerology, must have fascinated him, for he devoted the rest of his life to teaching a mysterious half-religious, half-scientific brotherhood, to whom "love of wisdom and philosophy was a way of life,"[1] and abstract science and useless numerology a device to free the soul.

When Pythagoras returned from his trips east he tried to share his new knowledge with the people of his native island, Samos. They weren't receptive, and near 530 B.C., Pythagoras, eager to continue his work, decided to migrate to southern Italy. He settled in the town of Croton, and there started his brotherhood. His school was the beginning of the Italian branch of Greek philosophy.

The whole idea of mortal life seemed futile to the Pythagoreans. The soul was a part of the divine spirit imprisoned in the cage of human frailties and emotions. To retire from life was to be nearer to the goal of all men. "Man's ultimate aim was to shake off the taint of the body, and, becoming pure in spirit, rejoin the universal spirit to which he essentially belonged."[2] The problem was to find a way to free oneself. Mathematics and abstract science were traditionally developed by priests and wise men who were vain about their discoveries and swathed them in mystery and divine implications. To Pythagoras mathematics was not only the gift of God, but God Himself. "The highest purification of all was just science, and especially mathematical science."[3]

So Pythagoras' developments of mathematical science were due partly to his fascination with numbers, and partly to his desire to elevate his soul. Mixed in with the scientific developments attributed to him are countless arithmetic tricks and religious interpretations for numbers that seem to us no better than superstitions and fortune-telling. Such precepts were so important to the Pythagoreans that all of their actions in daily life were centered around numerology.

Introduces Proofs

Probably the greatest contribution which Pythagoras made to modern science was not the discovery of new mathematical theories but the introduction of proofs for previously known facts. Even the famous Pythagorean theorem was known all over the Orient centuries before Pythagoras, but he was the first to prove its validity, so he commonly is credited with its discovery. Egyptians and Babylonians had advanced far in mathematical techniques, but no proof was ever given nor was there usually any indication of how a precept had been discovered. With the origin of proofs, mathematics became an

orderly science. Not that Pythagoras devised proof merely for the sake of logic—the first incentive probably came as a necessity from the desire to convince doubters of the truth in his teachings.

Pythagoras and his school really were amazing when one considers the state of science in Sixth Century Greece. Discoveries that we might classify as trivial were very startling precepts then. For instance, when the Pythagoreans discovered that some numbers (radicals) cannot be expressed by integers or ratios of integers, they had hit upon a completely new concept. Previously, the only known numbers were integers. It is an injustice to consider the Brotherhood only advanced magicians with little rational thought added—although much of their energy was spent on mystic nonsense. Being only human they could not escape some of the influence of the past, but their love of order and logic spurred them to accept nothing unless they believed they had satisfactorily proved it.

Abstract mathematics was considered much superior to practical mathematics, and the typical Greek mathematicians treated engineers with the utmost contempt. Experimentation was not condoned in the Pythagorean order; physical principles should instead be predicted by mathematical reason. It is ironic that some of Pythagoras' most important legacies to posterity came as a direct result of experimentation techniques that he later discouraged.

The experiments concerned the length of a taut cord that would produce different musical notes. He found that the lengths needed to produce an octave, a third, a fifth, and so forth were in proportions of simple whole numbers. The discovery astounded him, and enthusiastically he proclaimed that the ratios he found proved that the whole universe was run by simple numerical relationships. Just as musical scales were proportional, so astronomy, medicine, even human conduct should also be expressible in numerical ratios. (Pythagoras meant integral numbers, as they still were the only known kind.)

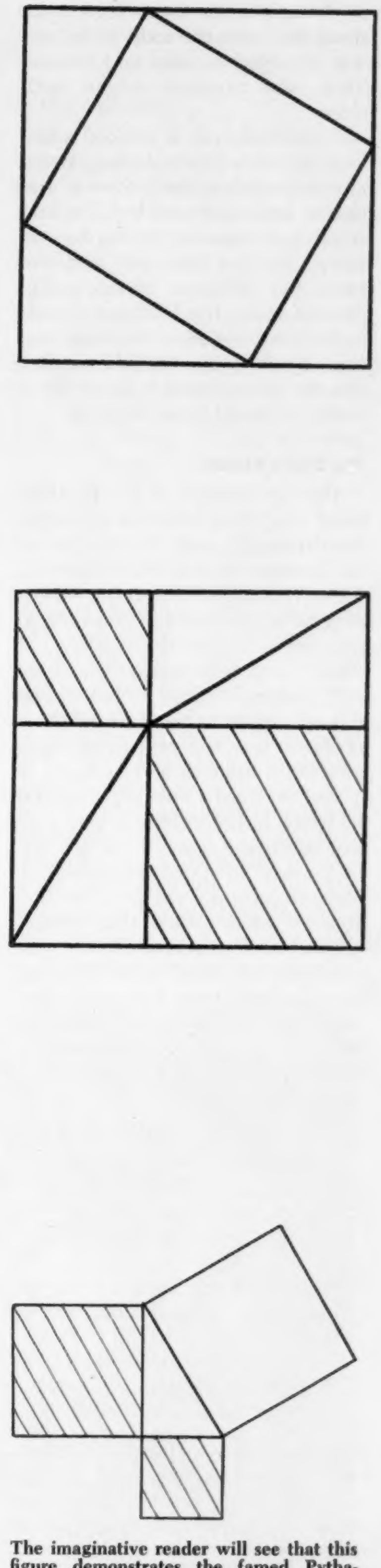
Not content to say that things could be expressed with numbers, Pythagoras claimed that everything *was* number. This opened the door to many mystic numerical properties. Thus Pythagoras left the field of pure science and dashed headlong into the religion of numbers.

Finite numbers in general were deemed good, as were limit, order and harmony. (Harmony in this sense does not mean literally musical harmony, but harmonic qualities of substances and their numerical characteristics.) Whatever was intelligible, determinable and mensurate was good, as opposed to the fantastic, vague or shapeless. The world was considered good, because it is a whole and thus is limited. It also is good because it is orderly; day follows after night, season after season, in predictable sequence. The Pythagoreans even made lists of good and evil quantities such as this:

Good	*Evil*
limited	unlimited
odd	even
unity	plurality
right	left
male	female[4]
at rest	in motion
straight	crooked
light	darkness
square	oblong

Pythagoreans argued that only what was strictly in order absolutely existed; lack of order was indescribable and unknowable, perhaps nonexistent. Pythagoras is reputed to have agreed to accept the people's gods only when he could find a mathematical formula to express them.

"Numerology is the faith that the universe can be summed up and compressed through a single grand formula to a unified whole comprehensible by human beings."[5] This must have been Pythagoras' sentiment when he proclaimed, "Everything is number." Substances that had numerical relationships, such as the musical scale, were expressed by them, and for items that did not already have such values numbers were assigned. Man was designated as three, woman, two, and accordingly marriage was five. One, being the first odd number, has often been mistaken for the number meaning man, but actually one was not considered a number by the Pythagoreans in the sense



The imaginative reader will see that this figure demonstrates the famed Pythagorean Theorem. (The third figure has been reduced in size to fit the space.) The proof Pythagoras discovered was the familiar proof by similar triangles.

of being odd or even. It was instead the base, the indivisible, and was regarded as holy and unique. Thus odd numbers began with three.

A contradiction is noticed when four is referred to as justice. Being an even number, the symbol is also that of femininity and evil. Yet four is unusual because it can be obtained by two plus two and two times two. Because of this useful characteristic, the feminine connotation was somehow waived, and four signified like for like, or "an eye for an eye and a tooth for a tooth," a brutal type of justice.

The Soul's Rebirth

The numerology of the Brotherhood was more religious in nature than scientific, and the purpose of its inventors was to free their own souls. The stages of a soul were expressed in the belief of transmigration of soul, or the "Wheel of Birth" as it was called. Undoubtedly patterned after reincarnation theories of the Orient, the Wheel of Birth was the rebirth of souls into other humans and animals. If a soul was pure enough, it would be freed, but otherwise it would go through many more lives, elevated or lowered in status depending on the virtue during the previous life. It is no wonder, then, that Pythagoreans were concerned about the condition of their souls. Wisdom and aloofness were two prime prerequisites for achieving the goal which was expressed by a sympathizer of Pythagoras, Empedocles, in this fashion:

> "Blessed is he who has gained the riches of divine wisdom. . . . For he is not furnished with a human head upon his body; he has not arms, springing as two branches from his shoulders; he has no feet, nor knees to run, nor hairy parts of generation. Rather he is a Mind, holy and ineffable, and that alone, flashing with swift thoughts throughout the whole order of the world."

Because they believed that souls were passed from creature to creature, the Pythagoreans were forced to abstain from eating any form of animal flesh. ". . . the beast or bird which you eat may haply be inhabited by the soul of your grandmother."[6]

Pythagoreans conceived that the soul consisted of three parts: reason, emotion and intelligence. Of these, reason is found among worldly creatures exclusively in humans, and is also found in the divine. Thus men themselves all have a bit of the divine in them, and the soul, then, is a minute particle of the Creator.

Politics Proves Downfall

Although the Pythagoreans tried to remain away from ordinary people's affairs, they could not resist the urge to rule those about them. Democracy was defined by Pythagoras as a tyranny of clever and untrustworthy men who fool the masses of ignorant people. The Brotherhood preferred to have society governed by a philosopher-ruler, who, having disciplined himself and searched men to find out the truth about human nature, would rule wisely, justly and efficiently. Pythagoras seemed the unquestionable choice for ruler, especially since he could expose the people to his truths which he had been teaching to the Brotherhood. Unfortunately, the Crotons were not enlightened enough to understand this. "If the people of Croton believed that to be conquered and told how to order their lives according to the supernatural mystic numbers was a loss of freedom it was only because they were absymally ignorant."[7] The people of Croton revolted around the beginning of the Fifth Century B.C., and Pythagoras and his followers were forced to leave. Pythagoras died shortly after; his disciples settled in Greece and started many small colonies there which flourished for awhile then disappeared.

The political upheaval of the Pythagorean school at Croton came just about the same time that crises were reached in both the scientific and religious fields. The disturbance of Pythagoras' scientific teaching concerned the assumption that "everything is number." After having based their whole plan of the universe on this, it must have been very upsetting to discover that some quantities, such as the diagonal of a square whose sides are integers, cannot be expressed in integers in the same system, although in the case of the square can be represented geometrically. Since radicals were not considered numbers, this showed that everything indeed was not number. The Pythagoreans had to change their premise to state that "things are like numbers."

The attacks upon the religious theories were directed mainly upon Pythagoras' conception of the divineness of human souls. The critics complained that if everything was supposed to be in harmony, then the soul should be an attunement of the body. Increasing interest in medicine caused people to regard the soul as a function of the body. These two ideas contradicted the premise that a divine soul is held captive in an evil body, for they insinuated that the body and soul were very closely related. Pythagorean methods of order and sequence in mathematical proofs were strong enough to survive the critics, but numerology and religion, after being adulterated in crude, underground societies, perished and are practiced no more.

Nevertheless, although the Pythagoreans flourished for only a short time, and Pythagoras did not make many original discoveries, the man and the group both stimulated mathematical study, and provided, through the method of proofs, a model for future derivations and rigorous proofs.

Another Story

Among the information amassed about a famous character from ancient history are always many legends and stories of doubtful validity. Here is a second story of Pythagoras—viewed from the legendary rather than the historically accurate viewpoint.

Pythagoras, after his eastern trips, began to teach in his home town. Not knowing anything about mathematical principles, the people became frightened and decided that Pythagoras was spreading some terrible form of magic. He was informed that he should leave Samos at once, so he set sail for Croton, where he thought he could lead the people in his way of thinking. Pythagoras considered himself quite superior, and had decided before he even arrived at Croton that it was only right that he should be a leader—he certainly wasn't going to take orders from anyone.

Milo, a famous athlete and war-

rior, offered to let Pythagoras stay in his house for as long as he wanted. Pythagoras accepted, and began to recruit followers.

Vital and persuasive man that he was, Pythagoras had little trouble convincing intelligent men that he was half-divine. His manners were austere, his actions wise and temperate. Although not always liked by the common people, Pythagoras was respected for his wisdom and lack of concern for human comforts. He sought and found disciples, whom he instructed to call him "The Master" and "Lover of Wisdom."

The Brotherhood was a strictly organized group that consisted only of those who were endowed with great self-restraint, self-discipline and intelligence. Anyone fulfilling these requirements was allowed to join—one didn't have to be rich to be a member of Pythagoras' school. Women were treated as men's equals in the group, a situation very startling in that era. All members donated their money and possessions to the community fund, and received from the society what they needed to live on.

The organization had an aristocratic air—Pythagoras claimed that hard work weakened the brain and left it unfit for constructive thought, so slaves did the labor. The members did exercises instead which were designed to stimulate thinking. Unfortunately, there is no record as to what such exercises consisted of or how much thinking they promoted.

Members were of two levels—mathematicians and listeners. After joining, one had to be a listener for at least three to five years and then had to be chosen as a mathematician. All listeners were on probation—any opportunity to ridicule or embarrass them was exploited to its greatest degree, for it was necessary to see if they could hold up under pressure.

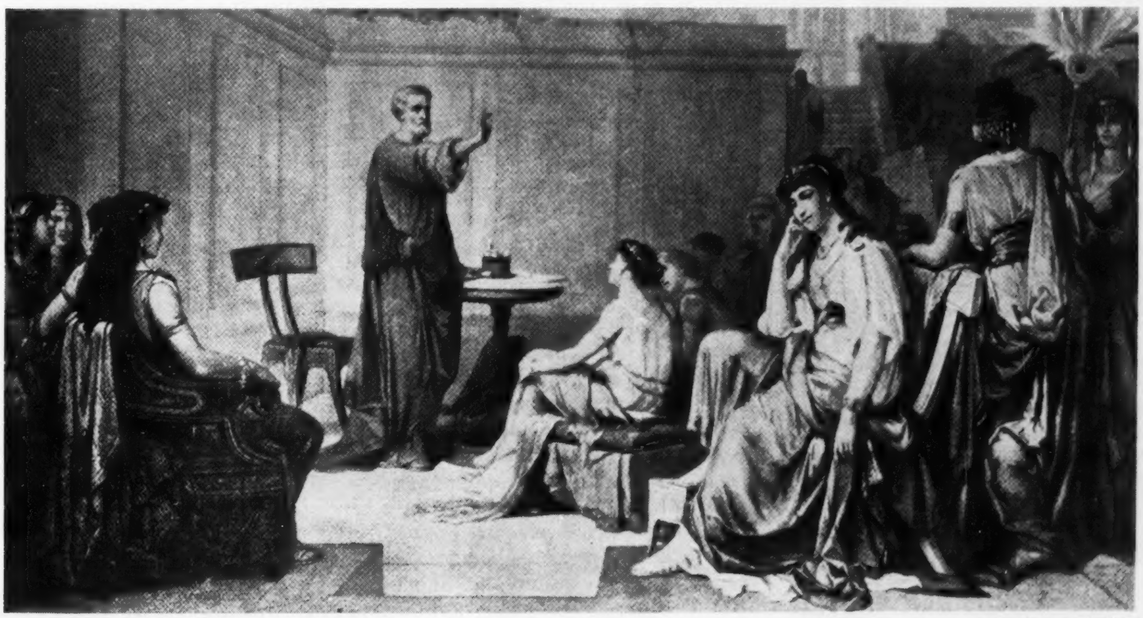
Every measure was taken to eliminate the comforts of civilian life. Of course, members ate no animal flesh, and there was reputed to be a taboo on beans, also. Wine, which to most of the members was a necessity of the civilian life they came from, was forbidden as one of the many temptations that had to be supressed. Only the scantiest, coarsest of clothing was provided, and each member had to learn to survive on merely three or four hours of sleep a night and still be able to contribute to the mathematical and numerological development which the society concerned itself with. It was pointed out to the members that of course they would want to practice celibacy if their entire lives were to be devoted to the purification of their souls.

All this was strictly voluntary—if anyone decided to resign all his possessions were returned, and he was under no obligation except to guard the secrets of the group.

A Rigorous Life

Day followed day at the same fatiguing pace: while it was still dark the members arose and began their exercises. After that, metaphysical poetry and inspiring music prepared them for solitary walks and meditation in which each one would plan his day and, if lax the day before, would choose some appropriate punishment. Finally, as the sun rose, breakfast of bread and water was served and the formal discussions of the morning began. Only the mathematicians could talk. The listeners remained absolutely silent in order to train submissive minds. All afternoon and all evening the discussion and meditations continued, with an occasional break for light relaxing talk—with the mathematicians doing the talking as usual.

Pythagoras is reputed to have been an excellent student of the psychology of masses—he needed to be, to cause anyone to voluntarily submit himself to the torturous daily life the Brotherhood led. Along with his mathematical proofs he included a few strange arithmetic relationships and the ever-present numerology, because he believed in them and because he knew that they were a sure way



Brown Brothers

Pythagoras lectures to some of his followers. Seated among them is Theano.

to keep his audience fascinated. Pythagoras always chose the most unexpected moment to appear, and his flowing white robe and beard and crown of golden leaves encouraged a reverent awe in those who beheld him. While playing the lyre in soft accompaniment, Pythagoras would speak decisively from behind a curtain to emphasize some of his most important announcements. Another trick he employed was to display a "golden thigh," which possibly was a physical disability that he used to his advantage.

Pythagoras' Marriage

In spite of Pythagoras' emphasis on being pure and detached from life, he occasionally slipped and was quite human. Yet even so, his followers must have been really surprised when he married. It is a wonder they did not denounce him for being a hypocrite. One of his favorite students, Theano, the daughter of Milo, his benefactor, had been infatuated with Pythagoras for years. Theano was a very lovely woman. When she finally blurted out that she loved Pythagoras and would go out of her mind if she had to repress her desires any more, Pythagoras, who was at first shocked, then pleased, decided that rather than risk rendering Theano insane he would make the supreme sacrifice and marry her. The marriage ceremony was performed in the Grotto of Prosperine, which seems a very strange place for a wedding, as the name suggests hell! The couple became parents of two sons and a daughter. In spite of nearly forty years difference in age, Pythagoras and Theano were supposedly very happy together.

With all the training to produce submissive minds Pythagoras rarely had trouble keeping the Brotherhood in line. One of the exceptions occurred when a member decided that he did not think two was the right numerical relationship for woman. It was his theory that woman should be considered four, because man, as three, would then come first. His idea didn't get far—he was promptly squelched by the statement that four was being used to mean justice—surely he didn't consider justice a womanly virtue? Also, if woman was four, the marriage number would be seven,—which already meant virginity and of course was not at all appropriate. Usually the discussions were a bit more sedate than this, but with equal uselessness.

And thus the Pythagorean Brotherhood existed, until their political aspirations brought upon them the wrath of the people of Croton, who didn't seem to enjoy living under Pythagoras' truth. This caused the dissolution of the Brotherhood. According to Diogenes Laertius, the same revolt that broke up the school indirectly caused Pythagoras' death, because of his taboo on beans:

> "He (Pythagoras) . . . settled in Crotona, . . . and incidentally, acquired great political power. Now, those were the days when totalitarianism was making serious inroads into Greek democracy, and so, as time went on, an opposition party arose which accused Pythagoras of dictatorial designs. A frenzied mob set fire to his mansion. The Master managed to escape, but having reached in the course of the ensuing pursuit a field of beans, he chose to die at the hands of his enemies rather than to trample down the sacred plants."[8]

And so as we leave Pythagoras, we wonder if we have glimpsed the truth about this man, or whether the real details of his life and the Brotherhood are irretrievably lost behind the dense cloud of legend.

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[1] F. M. Cornford, "Mysticism and Science in the Pythagorean Tradition," *Classical Quarterly*, XVI, (1922) p. 137.

[2] W. K. C. Guthrie, *The Greek Philosophers from Thales to Aristotle*, (London, Methuen & Co., Ltd., 1950) p. 35.

[3] "Pythagoras," *Encyclopedia of Religion & Ethics*, X, (Scribner's Sons, 1919) p. 527.

[4] I believe that Pythagoreans did not mean to condemn women as sinful, but classified them this way because femininity signified weakness and indecision.

[5] Eric Temple Bell, *The Magic of Numbers*, (Whittlesey House, New York, 1946) p. 77.

[6] W. K. C. Guthrie, *The Greek Philosophers from Thales to Aristotle*, (London, Methuen & Co., Ltd., 1950) p. 35.

[7] Homer W. Smith, *Man and His Gods*, (Little, Brown & Co., Boston, 1952), p. 156.

[8] Tobias Dantzig, *The Bequest of the Greeks*, (London, George Allen & Unwin, Ltd., 1955). p. 23.

STEREO RECORDING

by Robert Stern, EE '63

When high fidelity monaural recording finally came into its own, and was perfected, the recording industry looked for new ways to produce better and more lifelike recordings.

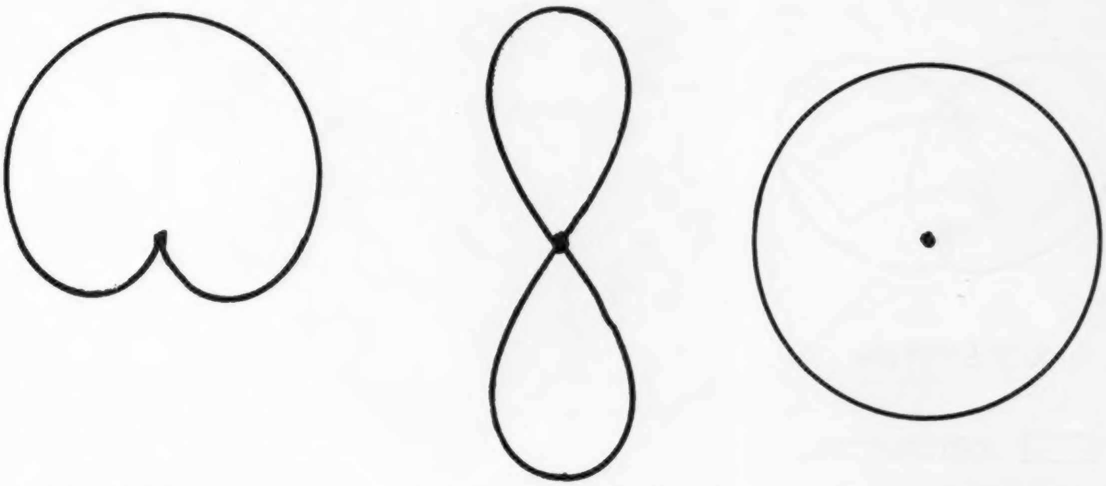
Stereophonic sound, which has been tried in various forms for years without much public interest, interested the manufacturers and the recording industry in general. But before any records could be sold, whole new techniques had to be learned—how to place microphones, how to cut the record or record the tape, and finally, how to reproduce the sound without any more distortion and other defects than regular monaural recordings.

To follow the development of the final product, the actual recording, it is best to begin with the recording apparatus, the microphone. There are three main types of response patterns which are of use in stereo recording. The first is the cardioid pattern which is so-called due to its resemblance to the human heart. It exhibits extremely good response in the front, with decreasing response toward the sides and no response in the back. The second is called the figure-eight for obvious reasons. It has good response at the front and back with little or no response at the sides. The third pattern is the omnidirectional mike, which has equal response in all directions.

All normal hearing is binaural, that is, heard with two ears. If only one microphone is used in recording, the resulting record or tape does not produce quite the same effects as the original sound source. The sound all seems to come from one point, whether the music be from a soloist or a large orchestra, and this is where stereo comes in. By using two or more microphones and recording their outputs on separate channels, the sound, when reproduced, will give directional effects. The word "effects" is used because the result is still not the same as if the listener were present at the recording studio. To produce true stereo, a wall of microphones would have to be used, and the sound would have to be reproduced by the same amount of speakers placed in the same positions as the microphones were. In this way, each sound would be caught and reproduced just as it came from the instrument, giving the ultimate in stereo. But this is unnecessary and would be fantastically expensive; multiplying the cost of stereo in order to get just a little bit better reproduction is senseless since adequate sound is produced from only two speakers. The three types of microphones described cannot produce good stereo if used alone. In most studios, a combination of them is used.

Microphone Placement

There are presently two methods of mike placement which are of importance. The first is the A/B system. The mikes are widely separated, and equally spaced from the center of the orchestra. If one violin, say, is to be recorded, the



A. CARDIOID PATTERN
•= MICROPHONE

B. FIGURE EIGHT PATTERN

C. OMNIDIRECTIONAL PATTERN

Fig. 1. Microphone pickup patterns.

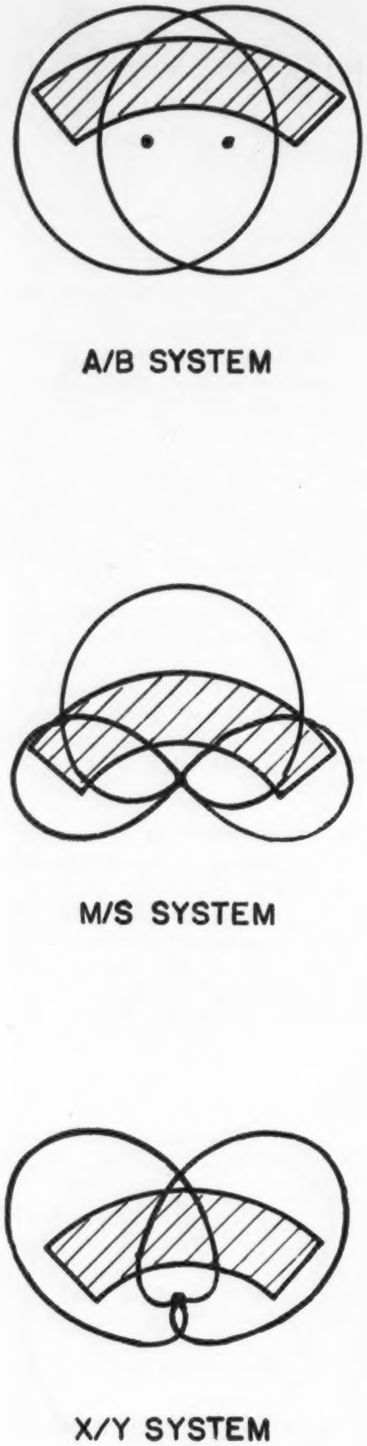


Fig. 2. This shows the A/B system, using two omnidirectional microphones; the M/S system, using one cardioid and one figure eight microphone; and the X/Y system, using two cardioid microphones.

volume of the sound reaching Mike 1 would be greater than that reaching Mike 2. Coincidentally, the sound arriving at the two mikes would have a certain phase relationship. The signals from the two mikes would be recorded on a master tape. When reproduced through two properly placed speakers, the original volume and phase differences would be heard by the listener and the brain would interpret the sound as if the instrument was in the same room.

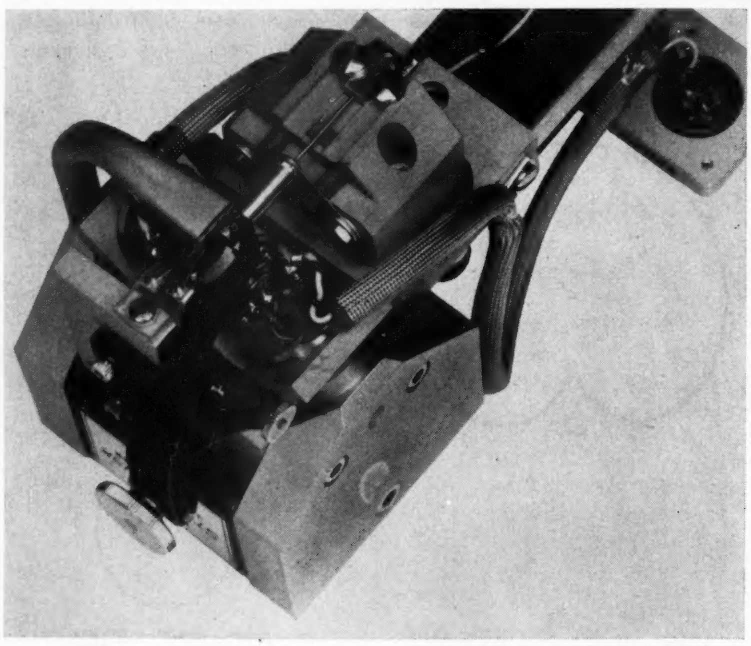
Some systems use an A/B/C-type arrangement with three channels instead of two. But unless the listener and recorder are prepared to somehow reproduce the third channel, its effect is lost. As it is, most third channels are equally divided between the left and right channels. The exact spacing of the mikes is dependent on the acoustic characteristics of the studio, the distance from the sound, and the type of mike used. In order to get optimum results, the speakers in the home should be placed as far apart as the mikes are in the studio.

The other main type of recording uses the M/S system. In this method, two mikes are placed very close together. A typical example of this is the use of a cardioid and a figure-eight mike mounted about the same axis, at right angles to each other.

By mixing auxiliary mikes into either channel, different parts of the performance may be emphasized. Extra mikes may be used to give better directional characteristics to a part, to strengthen a part or to correct weak spots in the orchestra.

If the outputs of the mikes were recorded directly, the results would be terrible, so they are modified by a sum and difference method which, when reproduced, creates the original sounds. One advantage of the M/S system is that the sound seems to come from between the two speakers instead of from two separate points. But M/S also uses auxiliary mikes to accentuate certain parts of the recording, and it is therefore difficult to draw a line between the M/S and A/B systems. Another less used system is the X/Y system which uses two cardioid mikes at right angles to each other with no alteration in the sound before it is recorded. The end result is similar to the M/S system. Of the three, the A/B system is the most flexible and easily adapted to different situations.

The problem of reproducing a solo instrument is a difficult one.



Joseph Jasgur

Fig. 3. A bottom view of the latest stereo recording head shows the magnetic coil and stylus. The flat, hollow tube curving in from the right is a vacuum for removal of chips from the record.

If the instrument is placed between the mikes, a stereo effect is created which is not characteristic of the instrument itself. This problem was solved experimentally with a piano by placing two mikes on a line with the piano, but with one a few feet behind the other. The resulting lower volume and phase difference at the further mike gave the impression of reality desired.

Making the Record

After the sound enters the microphones and produces an electric current, it goes to a master recording, usually a tape. Tape is also used as a finished product—like a disc, but its prime use so far is as an intermediary. As a recording medium, tape is not perfect, but it does have some advantages over the disc. It is reusable, spliceable, has freedom from the effects of wear, can be played immediately, and is of comparatively low-cost. There are also disadvantages: tape has a tendency to break or stretch; it must be threaded; and a certain place on the tape cannot be found easily or quickly. Also, tape reproducing equipment is somewhat more costly than other media. If reproduced sound is assumed equal to that of the disc, tape has some distinct advantages: in tape, there is no problem of moving parts which could alter sound reproduction; tape has a constant linear velocity while the linear velocity of a stylus depends on the diameter of the groove; recording tape has a constant uppermost recording frequency and level, while discs are limited because grooves will overlap on loud passages. The signal to noise ratio of tape is constant; the s/n ratio of a record depends on dust, wear, and which part of the record is being played. In one test, under extremely bad conditions, the signal to noise ratio of tape played at 7½ ips on half track with NAB equalization was at least 60 db at all times.

The main argument against discs is that a record is dependent on many system variables such as characteristics of the whole stylus-tone arm-turntable complex, width and diameter of grooves, and intermittent-type noise.

Cutting Heads

The cutting head is the implement which cuts the master record. One of the first American stereo cutters made was the Westrex A3. It first met the public eye at the Audio Engineering Society convention in October of 1957. A later model of the Westrex head is shown in the illustration. Essentially, in any stereo head, there are two moving coils attached to the stylus at right angles to each other. The design of the coils or stylus linkage may vary. Some of the cutting coils are mounted 45 degrees to the side, while others use a lateral and vertical cutting motion, both of which produce the same sound. The Fairchild cutter which was engineered by Rein Narma in the fall of 1957 has its stylus attached to the coils directly rather than through linkages. It uses the lateral-vertical method of recording. The Cook cutter is novel in that it uses magnetic motors instead of the moving coil type. Cook says that higher recording levels are possible with his method without the danger or blowups or burnouts.

As color television had to be compatible with black and white, stereo should be compatible with the old monaural type of recording. In other words, the monaural reproducing stylus should be able to extract a normal one track signal from the two which make up the stereo signal. One of the basic ways to solve this problem may be devised on inspection of the process which gives monaural sound. In the monaural method, the reproducing stylus moves only laterally, side to side. There is little, if any, vertical motion. Only the lateral motion produces sound, so if by some means, we could also have the stylus move up and down as well as laterally, we could conceivably record two channels in the space taken previously for one. In the Columbia Compatible Stereophonic Record, engineers devised a vertical-lateral system which compares very favorably with monaural recording methods. To be compatible with monaural cartridges, lateral motion had to be provided as well as some other angular motion for the other channel. A 90–90 degree system was impossible because if one channel were recorded vertically and the other laterally, the monaural cartridge would only receive the lateral channel and hence only half the sound. But if a sum and difference arrangement is used, the result is good and is compatible. If the sum (S), equal to the total volume from both channels, is recorded laterally, and the difference (D) which is recorded vertically is equal to the volume of the left channel minus the volume of the right channel, then $S=L+R$ and $D=L-R$. Referring to the diagram, the volume of L and R may be vectorialized. If only the left channel had sound, $D=L$, and $S=L$, so $L=S+D$ on the diagram. But the groove at this value is so shallow that the stylus would not track accurately and might skip grooves. If, on the other hand, there was sound only on the right channel, S would equal R, and D would equal $-R$, and R could be represented by the vector $S-D$. This groove would be deep and necessarily wide, resulting in considerably less playing time than a mon-

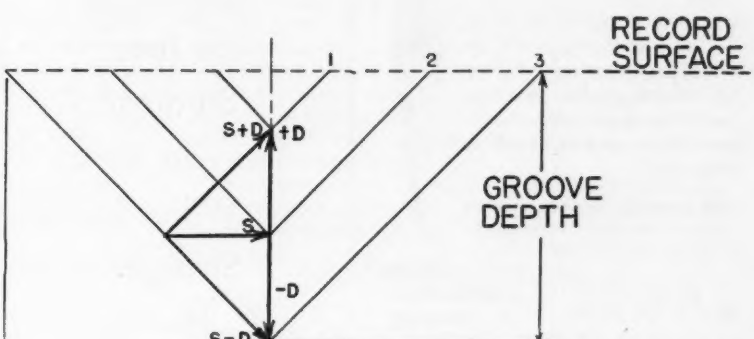


Fig. 4. Vectorial representation of the two channel record groove.

aural record would have. The problems of shallow grooves and less playing time make a system where the vertical movement is high undesirable. But if the same amplitudes are desirable on both channels, and the vertical motion must be reduced, some method must be devised to compensate for the loss in volume. If the difference in signal volumes is limited to a minimum, the variation in groove depth will be less and the desired effect will be achieved. Only one more thing is necessary: the difference signal must be continually varied so that it is at a minimum but still able to produce stereo effects in a stereo cartridge. This is accomplished in the Columbia system by a device called ASRA (Automatic Stereo Recording Amplifier). This device adjusts the vertical modulation continuously, making allowances for variations in volume with frequency. The amplifier is inserted in the D line and limits the vertical amplitude. Now if only one channel has sound, D does not equal L—R, and S does not equal L+R, they are not necessarily equal to one another. The vertical amplitude is only ⅛ of the lateral amplitude and the wear on record and cartridge is as low as the wear on a monaural record.

Editor's note: The industry standardized on a groove system in which the two channels are recorded on the two walls of a triangular groove. The walls are each at an angle of 45 degrees to the vertical and are therefore perpendicular to each other.

Stereo discs currently on sale bear the warning that they should not be used with monaural cartridges. Stereo cartridges, however, are supposed to give good results when used for playing monaural records.

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Creating a new world with ELECTRONICS

HUGHES

Photo Science

Dean Dale R. Corson

WELCOME TO THE FRESHMEN—

From The Dean

I wish to extend my best wishes to you freshmen who are just beginning your engineering training. A hard and exciting road lies ahead of you. The field of engineering is developing incredibly fast; the time lag from discovery to useful application has shrunk almost to zero. Fifteen or twenty years from now many of you will be working on problems which have not yet been invented. This puts a heavy burden on you to make the most of your opportunity here and on us in the faculty to provide the best possible program of engineering training. At the same time that the pace is quickening, engineering problems are becoming harder. Engineers are being asked to develop nuclear reactors, for example, which can produce useful power over long periods at temperatures in excess of 2,000°F. They are also being asked to design space capsules to carry human passengers and to return the passengers safely to earth.

What you accomplish during the next five years will have a profound influence on the remainder of your life and there are several things you should keep in mind in order to start off on the right foot. To a greater extent than ever before in your life, the responsibility for your success or failure is yours alone. You alone have to decide whether to keep up with your work or whether to let it slide. You alone have to decide whether to do your best work or whether to do the minimum possible to get by.

There will be many demands on your time and you must organize your time efficiently or you will be lost. You cannot do everything but you must do your academic work and you must have recreation. There are many extracurricular activities which may interest you and in which you may wish to participate. With proper organization of your time you will be able to join some of these activities. But take them slowly at the beginning, however. Wait until you see how you get along with your academic work; find out how much time you have available and then decide which of the extra curricular activities fit with your program.

I urge you to strive for excellence. If you can master your work at each step, subsequent work will become easier and more rewarding. The tasks which engineers must accomplish are of such importance in the world that anything less than your best effort is insufficient.

Every freshman feels at times that he is being asked to do work which has no connection with his future career. Let me assure you that all your work bears on your career. Every mathematics problem which you solve and every English paper which you complete contribute to the precision of your thought and to the clarity of your expression. At the same time, you are building a solid foundation for the more professional aspects of your training which come later.

You will have teachers whom you will consider to be good teachers and you will have others whom you will consider to be poor. Sometimes your judgment in these opinions will be sound and in other cases it will be unsound. In looking back on your work afterwards you may change your opinions. A "good" teacher is sometimes one who organizes his material so well and presents it so lucidly that you never have to do much for yourself and consequently do not learn as much as you might. A "poor" teacher may force you to organize the content of the course yourself, with beneficial results. At the same time that you pass judgment on your teachers, ask yourself what kind of student you are.

Finally, let me urge you to get acquainted with your advisor; find out when his office hours are and drop in to see him. Do not hesitate to discuss your problems with him; you may have problems he can help you solve. Perhaps he can give you advice about your study habits or perhaps you need some service which is available in the University and to which he can guide you. If you see him only when you want your course schedule approved for the following term, he is not apt to be of much help to you. Do not hesitate to call on me if I can help you.

For those of you who do your best, the future is bright. Work hard and enjoy your studies. You live in an exciting world. Make the most of it.

W.E. DEFENSE PROJECTS ENGINEERS are often faced with challenging assignments such as systems testing for the SAGE continental air defense network.

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Western Electric technical fields include mechanical, electrical, chemical, civil and industrial engineering, plus the physical sciences. For more detailed information pick up a copy of "Consider a Career at Western Electric" from your Placement Officer. Or write College Relations, Room 200D, Western Electric Company, 195 Broadway, New York 7, N. Y. And sign up for a Western Electric interview when the Bell System Interviewing Team visits your campus.

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Book Review:

A NEW APPROACH TO ELECTRONICS

PRINCIPLES AND APPLICATIONS OF ELECTRON DEVICES, Paul D. Ankrum, International Textbook Co., Scranton, Pennsylvania, 1959. Reviewed by Philip M. Seal.

What? Another textbook on electronics? This question immediately arose in the mind of this reviewer when he was first asked to review the manuscript of a new book on this subject by Professor Paul D. Ankrum.

What new features could an author include in such a text to make it compete successfully with the many other textbooks on electronics already on the market? Would it be written in such a way that students could readily understand it without too much "reading between the lines"? Would it concentrate heavily on the physics of electron devices with too little emphasis on circuit analysis? Or would it go to the other extreme and deal only lightly with the physical background of the devices, with the emphasis placed on the circuit theory? Would the text contain sufficient material on the newest of the electron devices, the transistor? And would the author present clearly the analogy between the transistor and the triode vacuum tube?

These are the questions to which this reviewer sought answers, and they deserve to be answered here. In the opinion of this reviewer, Prof. Ankrum's new text on electronics will compete successfully with the many other textbooks on the same subject. Although it is not an elementary text, it is written in such a way that the serious student will be able to understand the theory without "reading between the lines." The emphasis is definitely on the electronic circuit analysis rather than the physics of electron devices, but enough physics is presented to enable the student to understand the principles behind the operation of the devices.

Transistors and transistor circuits are definitely included. Here again the emphasis is on the equivalent circuit theory which is covered much more thoroughly than in many of the competing textbooks.

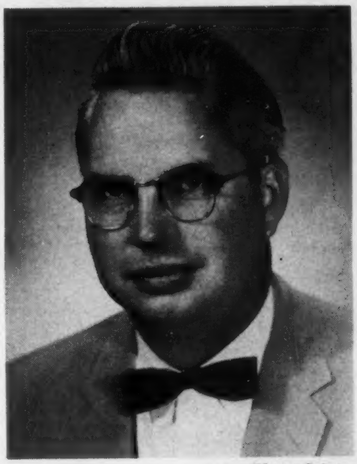


Photo Science

Professor Paul D. Ankrum

ABOUT THE AUTHOR

Professor Paul D. Ankrum is a native of Hamlin, Kansas. He received his A.B. degree from Ashland College, his B.S.E.E. from Indiana Technical College, and his M.S. from Cornell in 1944.

His teaching experience includes instructorships at Ashland, Indiana Tech, and Purdue. He came to Cornell as an instructor in 1942, became an assistant professor in 1944, and an associate professor of electrical engineering in 1949.

ABOUT THE REVIEWER

Professor Philip M. Seal received his B.S. degree in electrical engineering at Worcester Polytechnic Institute in 1930. He received his M.S. degree from the same school in 1932, and his Ph.D. from Purdue in 1949. He came to Norwich University in 1956 as an associate professor and he now teaches radio engineering along with other electrical engineering courses.

Although the amount of solid-state physics included is not sufficient to give a thorough understanding of just what goes on inside the transistor, the amount which is presented is unusually clear and is adequate for most engineering students. A very clear analogy between transistor amplifier circuits and vacuum-tube amplifier circuits is included as well as a comparison of the frequency-response characteristics of the two types of amplifiers.

The book begins with a chapter on "Electrostatics and Field Mapping," a subject which is omitted in most textbooks on electronics, but which is good background material for a thorough understanding of the behavior of diode and triode vacuum tubes.

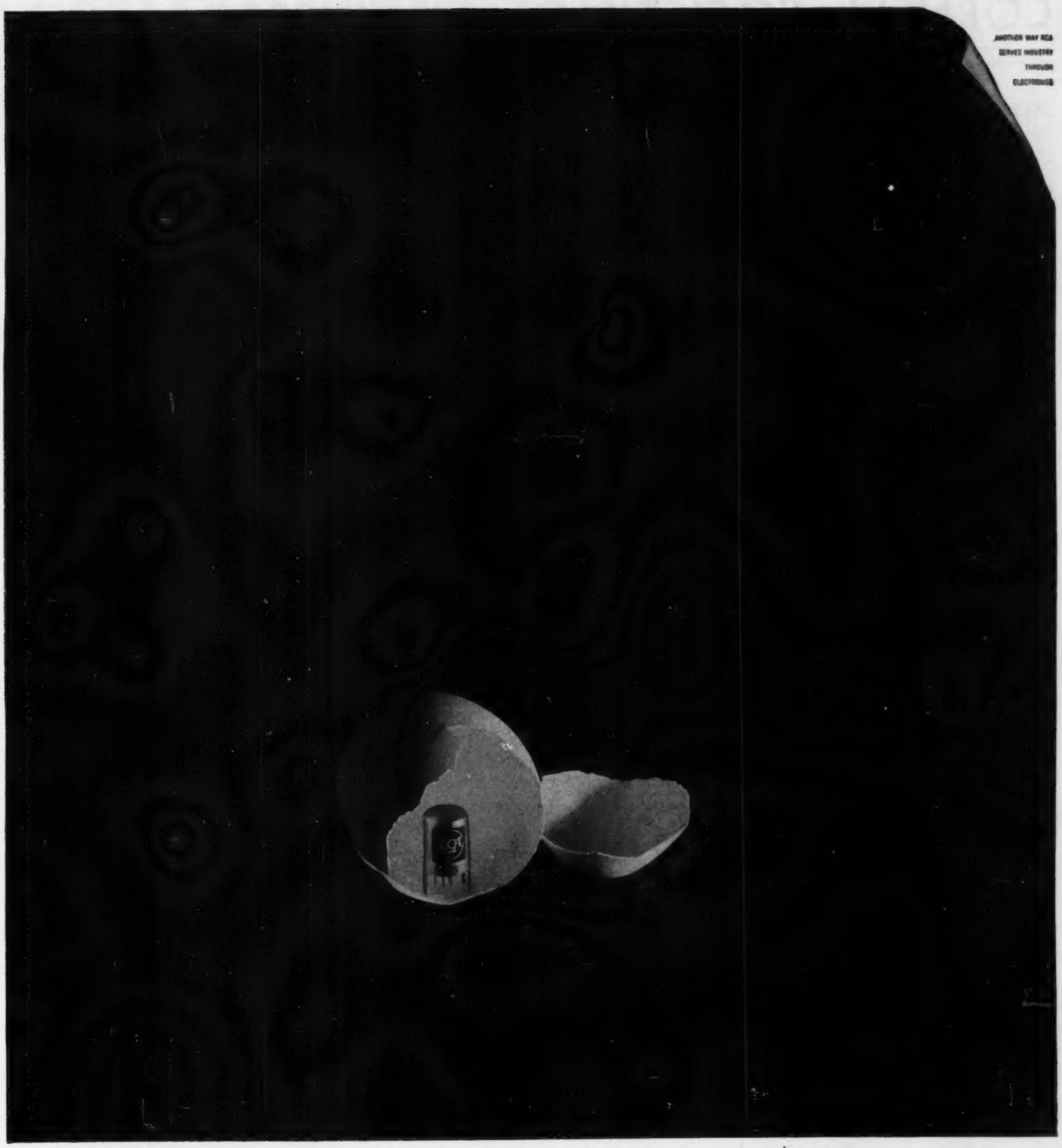
The chapter on "Electrical Conduction through Gases" is unusually thorough. Although this material is taken up earlier in the book than is the usual practice, it enables the author to present a very complete treatment of the subject of rectifiers in the following two chapters.

The chapter on large-signal amplifiers not only includes class A and class B amplifiers, but also includes the class C amplifier, which is a tuned-power amplifier which is commonly used to raise the radio-frequency signal of a transmitter to its required power level.

Because of the inclusion of the class C amplifier and because of the final chapter, "Modulation and Demodulation," Professor Ankrum's book becomes more than the usual textbook on electronics. This last chapter not only includes material on amplitude modulation, but also presents an analysis of frequency-modulated waves and shows how these waves are produced and detected.

In summary, *Principles and Applications of Electron Devices* is a book written especially for juniors majoring in electrical engineering or possibly in engineering physics. It would probably not be used in an elementary course in electronics for non-electrical majors such as mechanical, civil, and chemical engineering students, and it would probably not appeal to most engineers in the field who are looking for a quick answer to a specific question.

Enough material is included so that, if desired, the book could find continued use in a senior course in radio engineering. This feature, in addition to its many others, leads to the prediction that it will soon find its way into many college bookstores throughout the country.



RCA Electronics introduces the tube of tomorrow

Called the Nuvistor, this thimble-size electron tube is likely to start a revolution in electronics. RCA engineers scrapped old ideas—took a fresh look at tube design. The result will be tubes that are far smaller, perform more efficiently, use less power, can take more punishment, are more reliable. Developmental models now being tried out by designers will have a profound effect on the size, appearance, and performance of electronic equipment for entertainment, communications, defense, and industry in the future. It is another example of the way RCA is constantly advancing in electronics.

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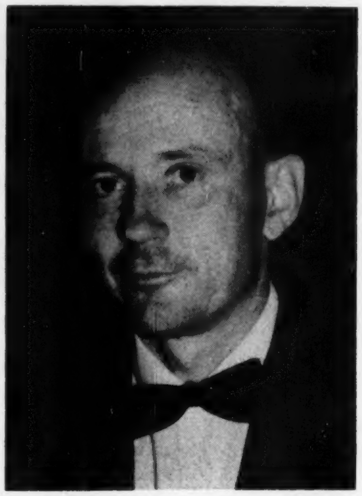


S. D. Teetor

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationship between the College and its alumni."

THE PRESIDENT'S LETTER—

To all the Freshmen, Undergraduates and Graduates, let me offer my best wishes. I shall do my best to try to follow up the many advances made these past two years by our Past-President, Roscoe Fuller.

At the beginning of the new school year, and with the many technological advances that have taken place, it might be well to remind the Engineer that there are simple engineering projects that need to be undertaken as well as complex projects, such as the conquering of space. A rough parallel might be drawn to the sign which used to be over the inner door of our old Armory Gymnasium. The sign, as I remember it was—"The man who so overloaded his ship with gold, so that it sinketh on the return voyage, earneth an ill return for his owner". The term "Practical Engineer" can be used to make all Engineers, graduates as well as undergraduates, think twice. It has come to my attention, in the past, that some of the best theoretical Engineers (who are very competent and can handle the most complicated problems, say, from modern airports, to radio telescopes), are totally lost when asked some very simple fundamental problems by a neighbor, such as how to stop the algae growth in the lake in front of a summer cottage, how many wheelbarrow loads of gravel to mix with sand and how many bags of cement; or for a simple cesspool installation behind their house. We Civil Engineers ought to get slightly red-faced when, at different times, some of our brothers have to confess to their neighbors that they cannot answer the foregoing questions. Of course it is excellent to master the latest technological advances, but do not sell short the basic fundamentals of everyday engineering. Therefore, be not so overloaded with the complex mysteries of the more technical engineering developments that one cannot take care of everyday problems.

STEPHEN D. TEETOR

ALUMNI ENGINEERS

Edited by
J. F. Thomas, ME '63

William S. Wheeler, M.E. '47, has been named a corporation vice president and general manager of the Motorola military electronics division. Formerly general manager of Motorola's Chicago military electronics center, Mr. Wheeler has been placed in charge of the company's entire military electronics division embracing activities in Chicago; Riverside, California; and Phoenix, where he will make his headquarters.

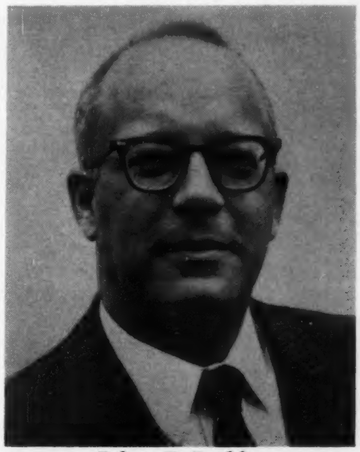
Mr. Wheeler joined Motorola immediately after his graduation. In 1953–54 he attended the Massachusetts Institute of Technology on a Sloan Fellowship, attaining the degree of Master of Science in Industrial Management. During his years at Cornell, Mr. Wheeler was a member of Tau Beta Pi, honorary engineering society, and Phi Kappa Phi, the national honorary society for outstanding participation in extra-curricular activities. He belonged to ATMOS, the Cornell University mechanical engineering society, as well as to Red Key and Sphinx Head.

Walter Lipkin, E.E. '49, has been appointed to the position of vice-president for operations of North Atlantic Industries, Inc., Westbury, New York. Mr. Lipkin, formerly vice-president and treasurer, will continue to serve as treasurer of the company. As vice-president for operations, a new post at North Atlantic, he will direct the company's plant and manufacturing activities. An immediate assignment will be the supervision of North Atlantic's program of facilities expansion, now under way and scheduled for completion during the last quarter of 1959.


Walter Lipkin

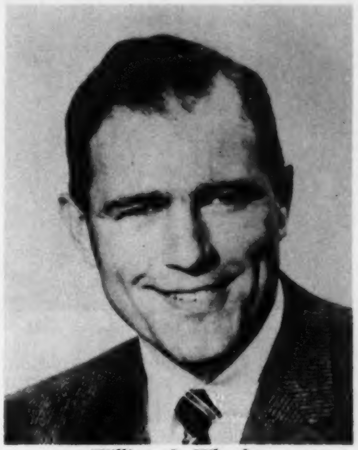
Mr. Lipkin was one of the founders of North Atlantic Industries. He has done extensive work in aircraft flight equipment, infrared detection, computers, and guided missiles instrumentation. Prior to the formation of North Atlantic Industries he held engineering positions at Sperry Gyroscope Company and at Hanson-Gorrill-Brian.

Howard P. Kallen, B.M.E. '50, and **Howard Lemelson, B.E.E. '49,** have opened a consulting office in New York City to provide mechanical and electrical engineering services for builders. (Kallen & Lemelson, 1820 Broadway, New York 23, N.Y.) They are both members of the Cornell Society of Engineers.


Robert F. Brodsky

Anatole Browde, B.E.E. '48, has been promoted to the post of departmental manager in charge of the advanced systems planning department within the missile engineering division's electronics department at McDonnell Aircraft Corp.

In his new capacity, Mr. Browde will be concerned with the establishment of electronic parameters for weapons systems and the assessment of prospective techniques and capabilities required to meet these parameters.


William S. Wheeler

Mr. Browde came to McDonnell from the Crosley Division of Avco Manufacturing Corporation, where he was associate director of the missiles and space department. He received his B.E.E. in communications from Cornell and did graduate work at Northwestern and Columbia Universities. Following his academic work, he was employed by the Capehart-Farnsworth Corporation, working on the development of the AN/APS 25 radar. Later assignments were with the Arma Corporation, where he did development work on the tail defense system of the B-52 bomber, and with Westinghouse air arm division, where he was project engineer in charge of development of the BOMARC target seeker.

Mr. Browde is a senior member of the Institute of Radio Engineers, a member of the American Ordnance Association, the American Astronautics Society, and the Cornell Society of Engineers.

Robert F. Brodsky, M.E. '46, has accepted the position as manager of the engineering services department on the technical staff of the weapons systems division of the Aerojet-General Corporation in Azusa, California. The aerodynamics, thermodynamics, stress and weights, and dynamics sec-

Kendall C. White

tions will fall under his direction. Dr. Brodsky was formerly chief of aerodynamics at Convair, a division of General Dynamics, Pomona, California. He received the Master of Aeronautical Engineering in 1948 and the Doctor of Science in 1950, both from New York University. Dr. Brodsky was also awarded a Master of Science in mathematics from the University of New Mexico in 1957.

Kendall C. White, E.E. '34, has been appointed director of Industrial Engineering at the corporate staff level of Thompson-Ramo-Wooldridge, Inc. Mr. White previously served as manager of industrial engineering and purchasing for the Tapco group and assumed his new post on June 1, 1959.

After receiving his degree at Cornell, Mr. White entered the employ of General Electric Company as an engineer. He served in the Signal Corps Supply Branch during World War II and the Korean War, attaining the rank of full colonel in 1952. Prior to joining Thompson in June, 1957 as assistant to the manager of the accessories division, he was production manager of the Wico Electric Company in Springfield, Massachusetts. From 1937 through 1941, and again from 1946 through 1951 he was a professor of industrial engineering at Cornell. Mr. White is presently a resident of Moreland Hills, Ohio.

Dr. Theodore Cotter, Ph.D. '53, and several other scientists at Los Alamos Scientific Laboratory have devised a scheme whereby space ships could be propelled by "solar sails."

Photons from the sun cause a small force on each unit area under illumination. By using a large enough sail, the forces could become appreciable and the space ship could be accelerated slowly.

Dr. Cotter and his associates have worked out solutions to many of the technical problems of the plan. They have devised a means of spreading the sail, a means of holding the sail in shape, and a means of maneuvering the space ship and sail in relation to the sun and the gravitational forces.

Robert T. Adams, E.E. '36, a research engineer at ITT Laboratories, a division of the International Telephone and Telegraph Corporation, recently received an award in recognition of his co-authorship of a technical paper which was published in June. It outlines principles related to over-the-horizon microwave radio communication, a technique advanced by the ITT Labs and now in operation over a 185 mile television-telephone link between Florida and Cuba. Mr. Adams joined the ITT system in 1945, after working for the Western Electric Company. He currently has the title of senior scientist and holds five patents with eleven pending.

Eugene W. Cornwell, M.E. '15, has retired as advisory engineer for the American Viscose Corporation plant in Fredericksburg, Virginia. Mr. Cornwell joined the Sylvania Industrial Corporation in 1930 as a plant engineer after having worked in the steel and automobile industries. Sylvania later merged with American Viscose. Mr. Cornwell was promoted to advisory engineer in 1954. He is a member of the Cornell Society of Engineers and the American Society of Testing Materials.

William Littlewood, M.E. '20, American Airlines vice president of equipment development has been appointed chairman of the National Aeronautics and Space Administration's Research Advisory Committee on Aircraft Operating Problems.

COLLEGE NEWS

Edited by A. Speare, Jr., EP '63

PROF. CHRISTENSEN TRAVELS TO INDIA

Professor N. A. Christensen, director of the School of Civil Engineering, has recently returned from a trip to universities in India sponsored by the International Cooperation Administration. The purpose of Professor Christensen's trip was to determine the type of aid needed for India's teacher-training program and the nature of participation Cornell University would be involved in if it assisted in the program.

Leaving on March 20, 1959, Professor Christensen visited the five universities that were selected as centers for training engineering teachers for Indian schools. Two of these universities, the Bengal Institute of Technology near Calcutta and Roorkee University in north-central India, will probably be aided by the University of Wisconsin. Likewise, the Indian Institute of Technology in Kuragpur will probably be receiving assistance from the University of Illinois. Professor Christensen also visited the University of Poona about 150 miles southeast of Bombay and Guindy College in Madras, the two universities to which Cornell will send professors if it joins the program. All of these universities are located in different parts of India to provide centers within reach of students in all states.

At all of these universities, Professor Christensen noticed the need for more extensive engineering education to provide skilled engineers for India's rising industry. Everywhere, Professor Christensen was struck by the great necessity for India to industrialize to improve the country's living conditions. He found that the universities use lecture teaching extensively but use laboratories and textbooks less than American schools. He feels that educational methods and procedures from industrial America are needed to produce better engineers for the industrialization of India.

A constantly recurring problem is the need for engineers to show laborers how to operate machines by running them with their own hands. Since manual labor has traditionally belonged to the lowest class, engineers dislike work with their hands.

Meeting with the Minister of Scientific Research and Cultural Affairs and other officials in Delhi, Professor Christensen learned that American schools can contribute most by providing professors that are capable of teaching engineering on a graduate level and have an understanding of American industry.

At present, Cornell is considering a contract with the ICA calling for twenty-seven man-years of professional help during the next three years.

Cornell is also participating in an auxiliary program in which selected students interested in teaching engineering are sent to United States universities for teacher training. Last year, Cornell had sixteen Indian students on campus under this program.

PROF. GOLD BECOMES CHAIRMAN OF ASTRONOMY DEPARTMENT

Professor Thomas Gold has been jointly appointed to the Cornell faculty by the College of Arts and Sciences and the College of Engineering. Having arrived this September, he is now serving as chairman of the astronomy department, director of radio astronomy, and professor of electrical engineering at Cornell.

Photo Science

Professor N. A. Christensen

Professor Gold was professor of astronomy at Cambridge for over fifteen years and comes to Cornell after two years at Harvard where he was Robert Wheeler Willson Professor of Applied Astronomy. He has been responsible for numerous widely held theories on the creation and nature of matter and originated the theory that the flat areas of the moon's surface are actually low places filled with dust. He has also published articles on the physiology of hearing and has proposed that the earth's crust drifts with respect to its axis, so that Hawaii might have been near the North Pole tens of millions of years ago.

Professor Gold's appointment represents Cornell's expansion in the fields of radio astronomy and astrophysics. He has served as senior principal scientific officer at the Royal Greenwich Observatory, has worked in radar research for the British Admiralty during World War II, and has also done research in zoology at Cambridge. He is a fellow of the American Academy of Arts and Sciences, a past councillor of the Royal Astronomical Society and a member of the American Astronomical Society and the American Geophysical Union.

TAU BETA PI HOLDS SPRING ELECTIONS

Members elected last spring to Tau Beta Pi, engineering honorary, include Professors Arthur H. Nilson and Paul Hartman, and graduate student Guy J. M. LeMoigne.

Others elected were Antony B. Casendino, John P. Evans, Richard F. Fellows, Karl A. Foster, David S. Fuss, Edward J. Ignall, Ben E. Lynch, William R. Quackenbush, Alan W. Riddiford, Robert Shaw, Jr., and Robert W. Weimman, all '60.

Also elected were David L. Brown, Ronald C. Dahlquist, Harry A. Fertik, Gerald B. Gilbert, Robert W. Hendricks, Noel M. Herbst, John S. Ingley, Donald M. Malone, David B. Mitchell, David T. Pow-

ers, James G. Rae, Robert A. Reinhard, Monte S. Riefler, David L. Ripps, Alan J. Seelenfreund, and Richard P. Spire, all '59.

COMPUTING CENTER MOVES TO LARGER QUARTERS

Returning to Rand Hall after a three-year interim, the Cornell computing department looks forward to new and better things. Since late 1953 when the department was started at the University, it has never had enough space to house its equipment. The original computer, the Card Program Calculator, along with its auxiliary equipment and offices was located on the third floor of Rand. When the opportunity for getting a better computer presented itself in 1956, the problem of space arose with the need for air-conditioning to cool the separate units of the computer. Hence, on the completion of Phillips Hall, the computing center moved into a special air-conditioned room of that building.

The new computer, the IBM 650, was used mainly for scientific computation. This machine also had auxiliary machines which were located in a room adjoining the main computer room. Since 1956, the 650 has been used by over fifty departments in the University as well as by other universities and neighboring industries.

Recently, with the increased need for a more useful and diversified machine, the computing center has purchased a later model computer. The old 650, which was rented from IBM was returned and was replaced by the newer Burroughs 220 digital computer. This new machine is physically much larger than the 650 and its arrival this summer brought up the problem of space once again. The decision was to move the computing center back to Rand Hall. With some twenty-eight units amounting to a total weight of 10 tons, the 220 needed more room and better air-conditioning. A 47-ton air-conditioning unit was therefore installed in Rand Hall to accommodate the need for greater cooling and humidity control. Occupying the entire first floor of Rand, the computing department is divided into four sections. Office space is greatly increased over that afforded in Phillips. There are secretarial and administrative offices and extra office space for special uses such as projects and data processing. Separate card-punching and auxiliary equipment rooms adjoin the large main computing room.

Photo Science

Stanton J. Peale

FORD INSTRUMENT CO. AWARDS FELLOWSHIP

Stanton J. Peale of Indianapolis, Indiana, has been selected as the 1959 winner of the Hannibal C. Ford Fellowship for a year of graduate study in engineering at Cornell.

Mr. Peale graduated this year from Purdue University where he was first in the honors program in engineering sciences. He plans to do his graduate work in nuclear engineering in the department of engineering physics at Cornell.

The Hannibal C. Ford Fellowship was established by the Ford Instrument Company which is one of the country's leading research, development, and manufacturing firms working on missile guidance, computers, and nuclear reactors. The fellowship is one of the most valuable fellowships for graduate study in engineering.

M.E. SCHOOL APPOINTS TWO NEW FACULTY MEMBERS

Associate Professors Carl Moltrecht and John Morton Allerige have joined the staff of the Sibley School of Mechanical Engineering this fall. Professor Moltrecht is working in the materials processing department and comes to Cornell from the University of Michigan where he did advanced work in machining, and process engineering. He has also done considerable work on the machineability of metals. He has also worked for the export division of Chrysler Corporation where he assisted in the coordination and solution of manufacturing problems for overseas plants.

Professor Allerige is instructing in courses in the department of industrial and engineering administration. He is a graduate of Yale with a M.S. in industrial engineering at Columbia. He has been management consultant for Allerton Chemical Corps in Rochester and has worked in the work measurement group for Eastman Kodak.

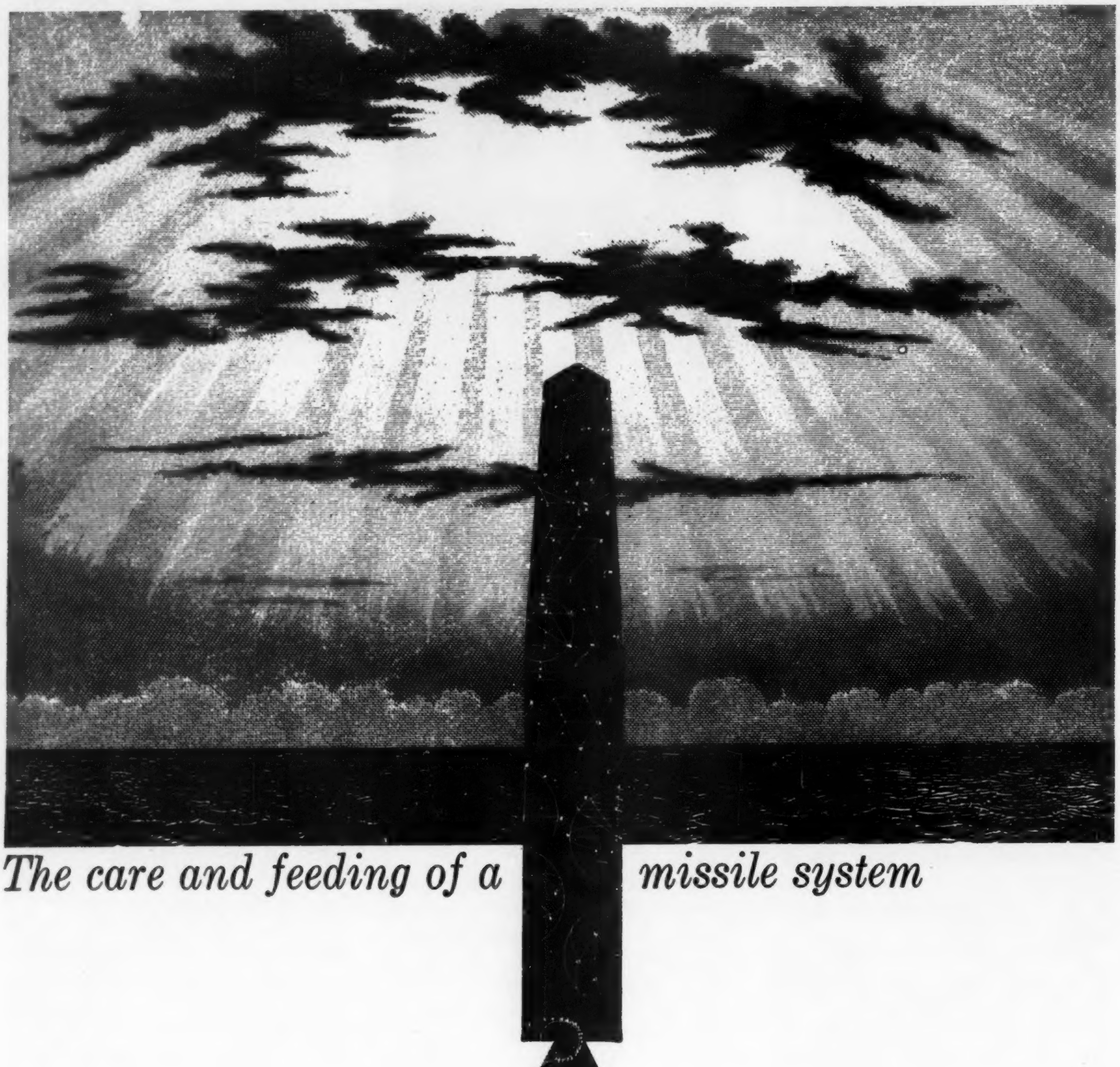
ARCHITECTURE STUDENTS PLAN FUTURE OF GARY, INDIANA

Recently, the city of Gary, Indiana, had an opportunity to see what it will look like if it follows a plan developed at Cornell University.

A redevelopment plan for the downtown business section of Gary was submitted to a group of civic, business, industrial and labor leaders who have been concerned with the effect of increasing traffic conjestion, absolescence of many buildings, and the growth in recent years of new suburban shopping areas designed to meet the problems of the automobile age.

A year ago, a group of city leaders requested the Cornell University College of Architecture to study a downtown development program for Gary, designed to overcome many present and prospective problems and to preserve the downtown district as the dominant center of the area for retail trade. At the present time Gary retail activities dominate a ten-township area which is expected to have a 265 per cent increase by 1980.

During the past several months, eight graduate students, under the immediate direction of Kermit C. Parsons, assistant professor of regional planning, and Robert D. Katz, assistant professor of city planning, have worked on the plan for the redevelopment of the district. They have examined material relating to future growth of the city and surrounding area, increased needs for highway control, trends in retail merchandising, and the like.



The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This <u>complete</u> job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Write to C. C. LaVene, Box B-600, Douglas Aircraft Company, Santa Monica, California.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of **DOUGLAS**

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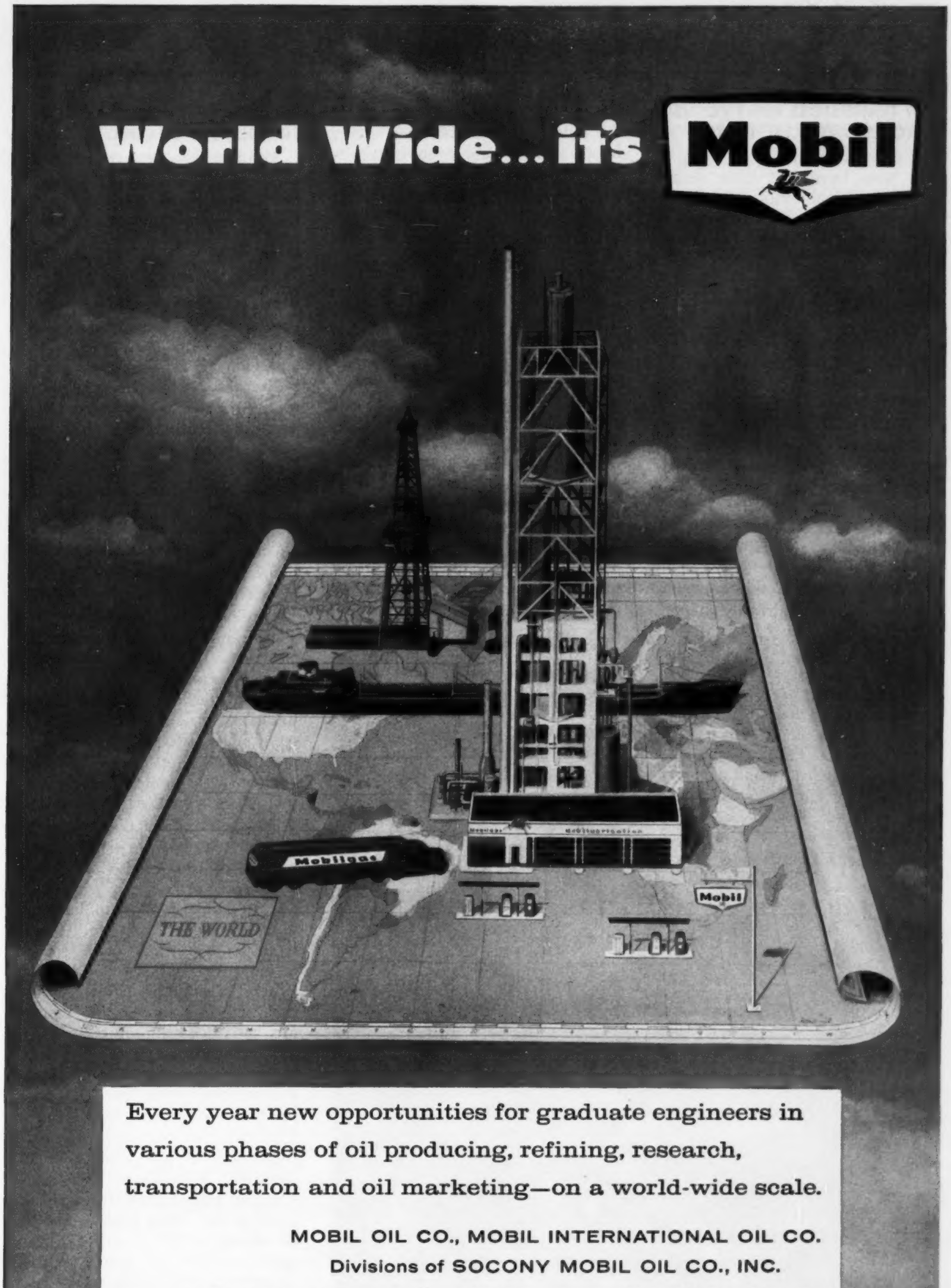
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TECHNIBRIEFS

Edited by R. H. Robinson, ME '63

NEW TRANSISTORS MAKE POSSIBLE IMPROVED ARTIFICIAL LARYNX

A new artificial larynx for persons who have lost their voices through surgical removal or paralysis of the vocal cords has been developed by Bell Telephone Laboratories.

With a minimum of difficulty and training, laryngectomees can use the new electronic larynx to speak conversationally. It is especially effective for conversing over the telephone.

By means of a finger-operated combination push-to-talk switch and inflection control, the user can easily control the pitch of his artificial voice, and thus give his speech a natural sounding quality previously unobtainable.

In principle, the new artificial larynx is a vibrating driver held against the throat. Completely self-contained and cylindrically shaped, it measures roughly 2 in. in diameter and 3 in. long. Thus it satisfies the requirement that the device be small enough to be inconspicuous. Included in this one small package is a modified telephone receiver serving as the throat vibrator, a highly efficient transistorized pulse generator with pitch control, and a battery power supply.

To use the unit, the laryngectomized person presses the vibrator against his throat. Switching on the pulse generator with his finger, he transforms vibrations transmitted into his throat cavity into speech sounds by normal use of his tongue, mouth, teeth, and lips.

Output speech volume obtained with the artificial larynx is equal to that of a person speaking at a normal conversational level, though the sound is a bit fuzzy and mechanical. Nevertheless, the frequency spectra of vowel sounds show that the frequency range transmitted into the person's throat is sufficient for satisfactory production of such sounds. And while intelligibility tests using the new device give results lower than those of normal speech, they are superior to those of any other artificial larynx. Users of the new artificial larynx can achieve a sentence intelligibility of 97 per cent or more, depending on their experience.

The output frequency may be varied from about 100 to 200 cycles per sec. by a rheostat which the user operates by pressure on the inflection control switch. In this way, he can change the pitch of his voice while he is speaking. For use by women talkers, the frequency range is adjusted to 200 to 400 cycles per sec. to correspond to the normal range of a woman's voice.

The man at the right is using the new artificial larynx while the one on the left is reading a sound-level meter to determine the intensity of the sound produced by the new device. Output speech volume is equivalent to that of normal conversational speech.

REACTOR THERMOCOUPLE USED TO PRODUCE ELECTRICITY

The first direct conversion of nuclear reactor energy into electric power was announced recently by the Los Alamos Scientific Laboratory.

The achievement was the result of an experiment with the newly developed "plasma thermocouple" placed in the core of a reactor. Modestly calculated to produce enough power to light an electric bulb for a few minutes, the lifetime of the device far exceeded all expectations. Acting like a superpowered flashlight battery with an open circuit voltage of 3.8 volts and a short circuit current of between 30 and 40 amp, the thermocouple was operated at design efficiency for almost twelve hours before it was shut down and dismantled for analysis.

The two-metal thermocouple is a well-known means of producing electricity by bringing two different metals maintained at different temperatures into contact. It was found that substituting ionized cesium gas (plasma) for one of the metallic elements produced direct current at several hundred times the power of earlier thermocouples.

The experimental plasma thermocouple resembles an empty frozen fruit juice can in size and shape. The source of power is a rod about ¼ in. in diameter and ¾ in. long containing enriched uranium. The rod is suspended in the center of the cell and surrounded by cesium gas. When the assembly is lowered into the core of a reactor, the neutron flux activates uranium fission heating in the center of the can while the flow of reactor coolant around the outside of the can drops the temperature of the cesium plasma. The essential requirements of a thermocouple are thus met and electricity is produced.

When this single cell is extrapolated to an entire reactor, the implications of a successful plasma thermocouple to future atomic energy developments are enormous. Present fission reactors produce high-pressure steam to power huge turbines which in turn make

the conversion to electricity. If it would be possible to bypass the turbines, the weight and complexity of reactors would be greatly reduced.

INORGANIC FILM PROVIDES HIGH-TEMPERATURE WIRE INSULATION

Many potentially important applications of electrical circuitry at high temperatures are presently hindered by the lack of high-quality flexible wire insulation. Recent discoveries at Bell Telephone Laboratories indicate that fluoride coatings on wire of copper, aluminum and some other metals will provide exceptionally high insulation values at elevated temperatures, yet still remain flexible and free from porosity.

The insulating coatings are formed directly on freshly cleaned copper or aluminum. The metals are exposed to oxidizing carriers of fluorine such as hydrogen fluoride or elemental fluorine at temperatures from 300 to 600 C. The thickness of the resulting copper fluoride and aluminum fluoride films depends on the temperature at which they are formed, the concentration of the fluorine, and the time of exposure. Aluminum forms a fluoride film 1 micron thick in a few minutes at 550 C. These films remain adherent when bent repeatedly at right angles.

Electrical insulation values are very high for both copper and aluminum films, being of the order of 10^{10} ohms at room temperature for films of the order of 1 to 2 microns thick between probe electrodes one-quarter in. in diameter. The films retain their excellent insulating properties at high temperatures. For example, aluminum fluoride films exhibit resistances of about 10^{9} ohms at temperatures as high as 500 C.

The aluminum fluoride films show excellent resistance to oxidation even above 600 C. They also show no tendency to hydrate or dissolve on exposure to high humidity. The insulation does not break down even at 450 v at 500 C.

Even the best organic insulating coating cannot be used continuously above 300 C. Inorganic insulators are generally porous and nonflexible, although some may be used at temperatures as high as 830 C. Insulating fluoride coatings should be satisfactory almost up to the melting point of the conductor.

This new approach to insulation could provide the answer to some of the problems of missile re-entry guidance systems, as well as to other more earthbound high-temperature electrical problems. The technique is not limited to copper, but can be used to form thin, flexible films on other metals as well.

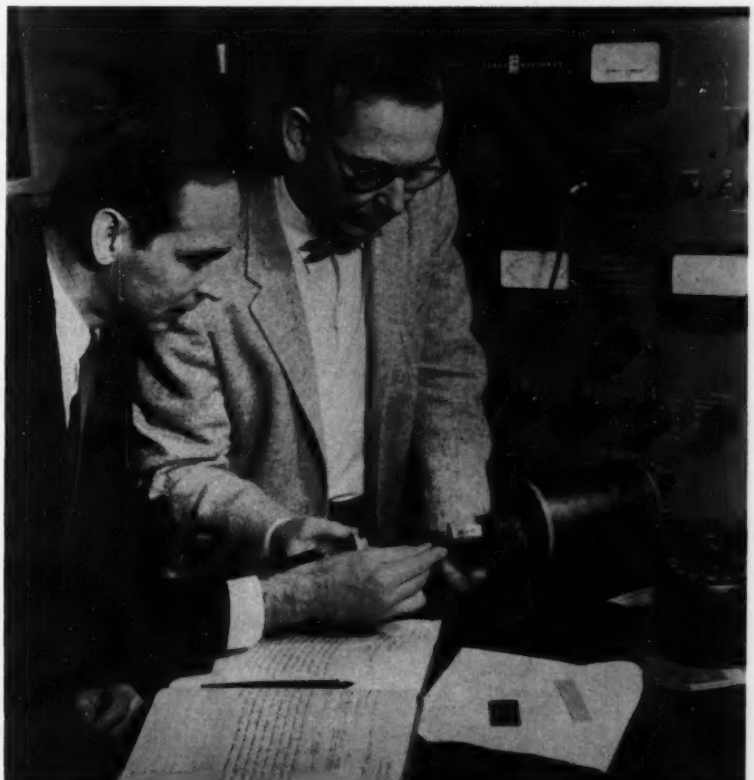
MECHANICAL ROBOTS USED FOR REACTOR MAINTENANCE

Automatons are being designed to perform reactor maintenance and repair operations in radiation fields too "hot" for humans. These mechanical robots are being developed by the Babcock & Wilcox Company's Atomic Energy Division, Lynchburg, Virginia, and the B&W Research and Development Center, Alliance, Ohio, for use in Lynchburg.

The robots are one phase of a facility established by B&W to develop prototypes of equipment required to maintain advanced types of reactors that will circulate liquid metal as the atomic fuel. Known as the Engineering Prototype Development Facility, the unit was constructed under a contract B&W holds from the U. S. Atomic Energy Commission to study, develop, and build an experimental circulating-fuel reactor.

The largest and most complex robot is a three-ton, eight-foot high fork-lift truck with three arms especially adapted to perform repairs on the reactor. The most versatile of the three arms is a mobile manipulator capable of duplicating many human wrist and arm motions. The two auxiliary arms can easily lift a small wrench or a 1000 pound object 15 feet in the air.

The other electronically-controlled units are a tow-truck for transporting radioactive loads; a pipe welder which can complete a high-integrity, six-inch weld in thirty seconds and is equipped with a television "eye" which permits examination; a pipe cutter that can cut a 10-inch diameter pipe; and a 50-ton "flying rope" crane



Bell Labs

Two Bell Telephone scientists inspect a strip of aluminum coated with their new electrical insulation after subjecting it to high temperatures in a small muffle furnace. The new insulation is formed right on the surface of aluminum or copper by exposing it to oxidizing carriers of fluorine.

with a drive mechanism located in an accessible position behind the radiation shield rather than on the bridge in a radioactive work area.

WIND TUNNEL LABORATORY SIMULATES SNOWSTORM

A raging snowstorm, complete with swirling gusts, mounting snowdrifts, and rippled snow surfaces, was simulated recently in the wind tunnel of the research division of New York University's College of Engineering. The miniature manmade blizzard came as a climax to eighteen months of intensive studies and tests.

For the past year and a half, the research division has been conducting an investigation for the U.S. Army Corps of Engineers to determine the feasibility of producing accurately modeled snowstorms in its wind tunnel facility. The models will be used to study the fundamental characteristics of drifting snow and the problems of snowdrift control encountered on the Greenland Ice Cap and in other polar regions.

The demonstration used borax to simulate snowflakes. The size of the flakes was scaled down to correspond with the size of the tunnel itself and of the models of buildings placed in the tunnel.

Now, using models of specific designs for buildings, snow fences, and other structures NYU researchers will make tests to determine whether these structures will be able to withstand the contracting and swelling of permanently frozen ground and the erosion of snowdrifts. Among the buildings modeled will be those that are to be constructed in Greenland for the U.S. Air Force's Distant Early Warning Line.

NEW ELECTRONIC TUBE CAN SEE SPLITTING ATOMS

An advanced type of image intensifier tube that can "see" a splitting atom or the faintest star has been developed by the Westinghouse Electric Corporation's electronic tube division.

The new tube amplifies the light entering at one end to produce an image as much as three thousand times brighter on the fluorescent screen at the opposite end.

The most important use of the new device is expected to be in the nuclear field, where it will permit photographic records of atomic particle reactions. The tube has already been used in a luminescent chamber system to produce photographs of light from the path of a single atomic particle.

With the new tube, pictures can be taken of the minute light scintillations that occur when certain materials are struck by nuclear particles produced by "atom smashers." The nature of these fleeting scintillations gives much information on the nuclear reaction being observed.

In astronomy, the image tube can further intensify the output of giant telescopes when viewing very faint stars. It could also be used in satellites to obtain pictures of far-distant stars and galaxies.

The tube can reintensify its own output if the output signal is led back through the tube by a system of mirrors. Four of the tubes feeding into each other with lenses would be able to produce a picture of a single photoelectron.

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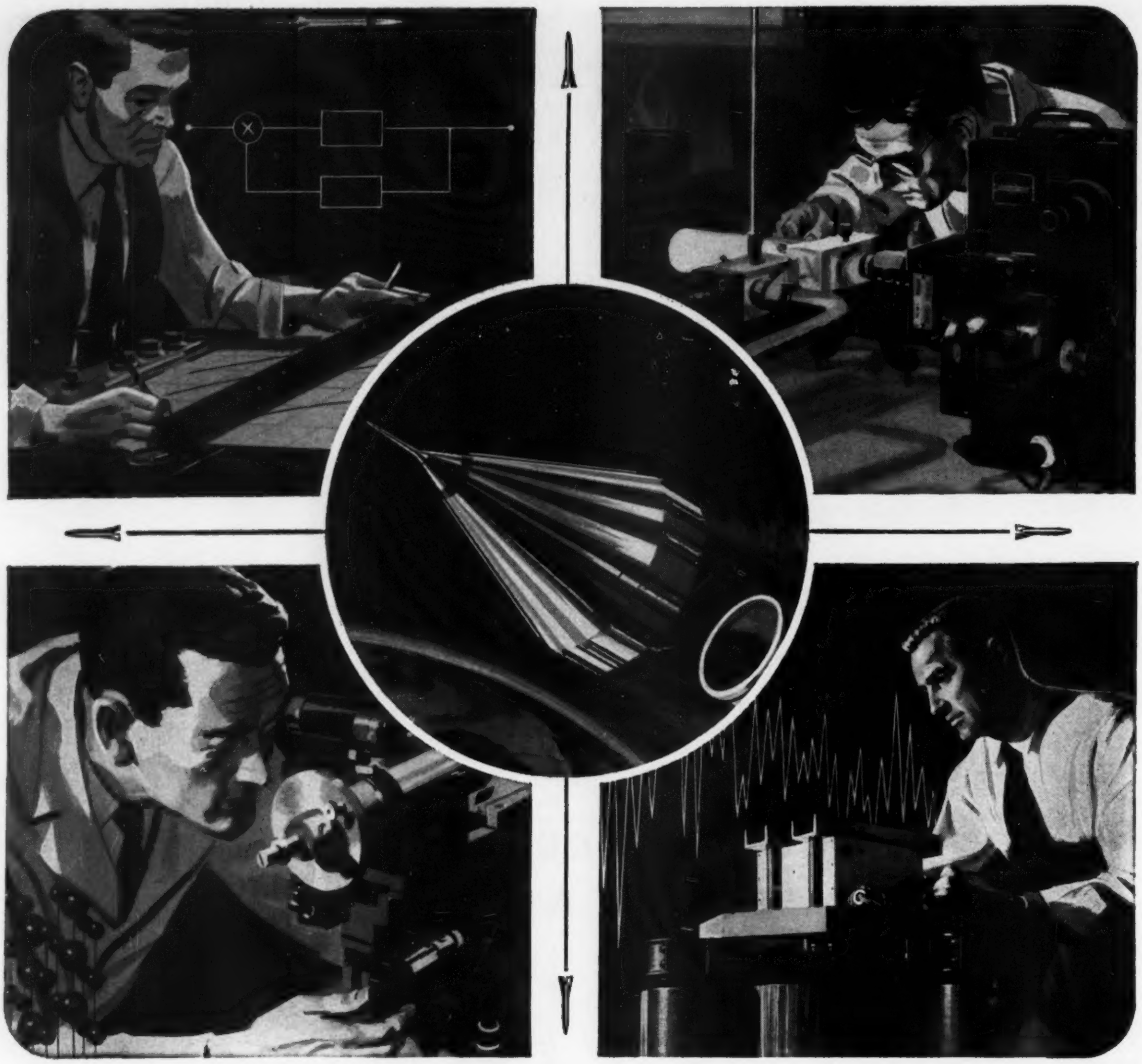

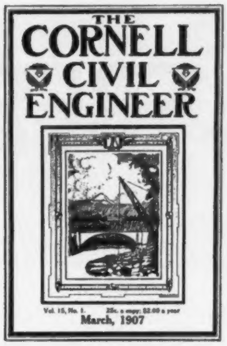

FIFTY YEARS AGO IN THE ENGINEER

Edited by J. F. Shapiro, ME '61

Each registration day the students of Sibley College are heard to complain of the great amount of time taken and the numerous difficulties encountered before registration is complete, and before the student has his program for the term clearly in mind. It is our object therefore to explain, as clearly as possible, why so much time and attention is necessary for each student when registering.

There are two ways of advancing students. First—if they fail in more than a certain percent of their work, to make them take the whole course over again. Second—to let them pass up what they may and forge ahead as fast as possible. This leads to three classes of students: (1) those behind in their course; (2) those ahead of their course; and (3) students coming from other institutions where courses are entirely different from those given here. The result is that the three classes are, technically speaking, out of phase.

Now—all of the above men wish to complete the same course at identically the same time and the result is a splitting up of the prescribed course to suit the particular student. Consequently there were, in the combined Junior and Sophomore classes of Sibley College of last year, only about 25 *regular* students—*regular* meaning those taking the *prescribed* course.

It was formerly thought that the best way would be for the students to pick their own courses and to rely upon their own good judgment in taking the studies necessary to complete the engineering course in four years. This, however, was found impracticable as the students, either through misguidance or ignorance often chose the wrong studies so that in many cases they could not complete the work in four years. As an example of this—we find students omitting the course in mechanics in their Sophomore year, making it almost absolutely necessary to remain an extra year to get in those studies which cannot be taken prior to a thorough study of mechanics.

The faculty of Sibley have consequently inaugurated the much misunderstood *class advisory system*. By this system—each student must at the beginning of each term consult his *class advisor* and find out whether the work he is taking is sufficient or insufficient to finish his course at the desired time. The result of the above system has already been shown in that the class of 1906 was the best prepared that has ever left Sibley College to enter the engineering field. (*Sibley Journal*, October, 1907)

Undoubtedly the most memorable portion of a Civil Engineering course at Cornell is Junior Camp. Underclassmen know about it in a vague way and Juniors look forward to it, becoming eagerly excited as June approaches. But when one has been there, then it assumes proportions. It is of course principally for technical instruction and practice; but its schooling in human nature is of no secondary importance, being a splendid leveler that rubs off all civilized veneer. Working, eating and sleeping together rapidly brings out the native metal, and so it is here that a class comes to really know itself. By the end of its Junior Year the class is pretty well acquainted, good feeling is prevalent, and the conditions are just ripe for forming friendships. Camp gives the opportunity, and binds the entire class together in a way that bodes well for the future. Certainly it is this phase of camp that is most appreciated.

. . . A soup plate of hot cereal just creates a slight warmth, and many cups of steaming coffee and thick steaks are needed to start the benumbed being into activity. *The Civil Engineer*—October, 1909.

In a lecture given recently at the Royal Institution, Prof. Sir James Thomson said that matter is neither continuous nor homogeneous. He showed by an experiment that hydrogen can be passed into a vacuum bulb through an incandescent platinum window. In a similar way sodium passes through glass and this is a useful fact in the manufacture of vacuum tubes, as sodium can be passed into the tube to absorb the residual oxygen. Belatti, the Italian physicist, has shown that hydrogen can pass through cold iron. Matter may therefore be generally regarded as full of holes. *The Sibley Journal* —October, 1909.

A problem on which the engineers of the Association of Licensed Automobile Manufacturers have, with unparalleled success, spent a good deal of study and experimentation is that of making quiet-running gas engines for the cars of the A.L.A.M. members.

Some of the principal causes of timing-gear noises are inaccurate machine work on the crankcase, causing too wide variation in the distance between gear centers; unsuitable crankshaft and camshaft bearings, causing jumping of the shafts when the motor is running; inaccurately spaced and poorly designed gears, causing warping after the strain of cutting the teeth is removed. The utmost care must be taken in fitting up cam gears, and sometimes one or two of the gears may be changed to good advantage, even though they are apparently the same size and shape. *The Sibley Journal*—October, 1909.

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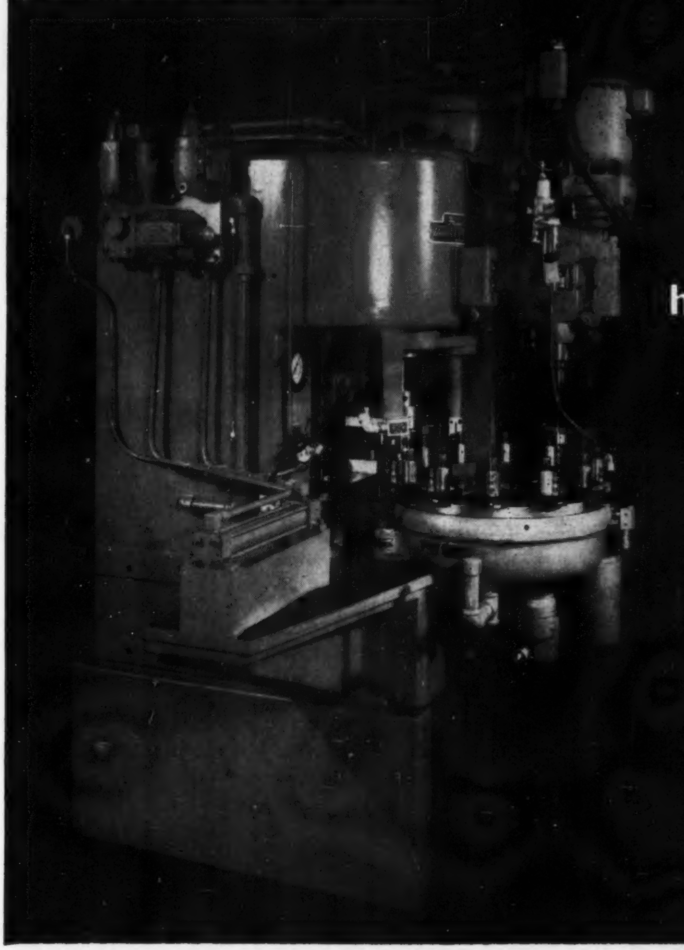

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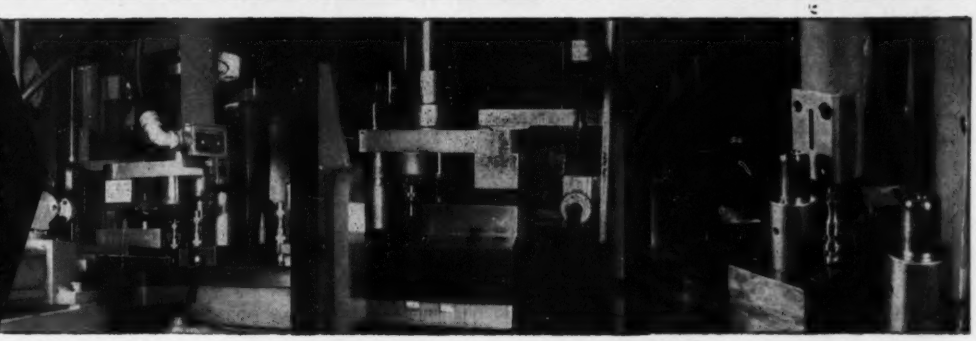

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STRESS *and* STRAIN . . .

Edited by D. J. Martin, ME '62

A young lady from South Carolina was in the hospital for a check-up.

"Have you ever been X-rayed?" asked the doctor.

"No," she replied, "but ah've been ultraviolated."

° ° °

Mother rabbit to her small child: "A magician pulled you out of a hat—now stop asking questions!"

° ° °

The long-winded lecturer had been holding forth for over an hour, except for brief pauses from time to time to gulp a hasty drink of water. Finally, during one such intermission, an old man in the audience leaned toward his neighbor and announced in a loud whisper: "First time I ever saw a windmill run by water!"

° ° °

The plumber was introducing his new assistant to the niceties of the trade.

"Above all," he said, "you must exercise politeness and tact."

The assistant allowed as how he understood about politeness but, what is tact?

"Well son," he replied, "it's this way. If you walk into a bathroom to fix a pipe and a young lady is in the tub, you close the door and say, 'Beg your pardon, sir.' The 'Beg your pardon' is politeness. The 'sir'—that's tact."

° ° °

"I've heard you've had a terrible time with your jalopy."

"Yeah."

"What happened?"

"Well, I bought a carburetor that saved 30 per cent on gas, a timer that saved 50 per cent on gas, and spark plugs that saved 30 per cent on gas, and after I drove 10 miles the darn gas tank overflowed."

° ° °

Two wealthy industrialists fell into an argument about whether the Russians were really our friends or not. The one who admitted that they were said, "Why, I'll bet I could ride a Russian ship to Russia, tour the country, and nothing at all would happen to me."

The other man called his bet and the sum was set at one million dollars. Two weeks later as the Russian ship left New York harbor, the ship's captain called the Americans from his cabin. "We haff cable for you from New York, friend," he snarled. "Read it."

The American, puzzled at the captain's belligerent manner, looked at the cable. It read: "If you can't get Khrushchev, try for Mikoyan."

° ° °

M.E.: "Were you ever in a really tough situation?"

C.E.: "Yes, once I was in quicksand up to my neck. But my brother was in a much tougher spot."

M.E.: "Yes? How was that?"

C.E.: "I was standing on his shoulders."

° ° °

"Was your friend shocked over the death of his mother-in-law?"

"Shocked? He was electrocuted."

° ° °

"Professor," said the engineer in search of knowledge, "will you try to explain to me the theory of limits?"

"Well, John, assume that you have called on a pretty woman. You are seated at one end of the divan and she is seated at the other. You move halfway toward her. Then you move half of the remaining distance toward her. Again you reduce the distance separating you from her by 50 per cent. Continue this for some time. Theoretically, you will never reach the girl. On the other hand, you will soon get close enough to her for practical purposes."

° ° °

Prosecuting Attorney: "You mean to say you had sixteen beers and didn't move from the table once the night of the murder."

° ° °

A lonely chick taking a look around the electric incubator of unhatched eggs—"Well, it looks as if I'll be an only child. Mother's blown a fuse."

° ° °

Customer: "I'd like 15 cents worth of quinine, please."

Druggist: "Here you are sir."

Customer (a moment later): "Help, I'm poisoned."

Druggist (looking at the box): "You're right, it's strychnine. That'll be 10 cents extra. Pay me quick, that stuff works fast."

° ° °

At last, after months of intensive searching, we have stumbled upon the vast underlying difference between those two bitterly opposed factions of modern science, physics and engineering, and we hereby present to you the fruits of our untiring efforts in hopes of broadening your outlook on this phenomenal situation.

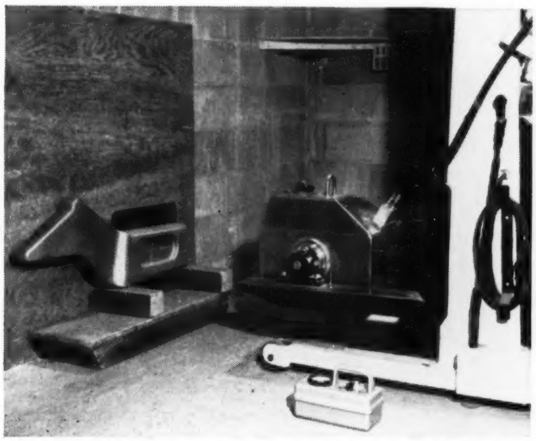
The physicist claims that the inch, by definition, is that given length of thoriated tungsten wire .0563 mm. in diameter which when heated in argon to a temperature of 1535.35 C in an evacuated atmosphere of 5.54 cm. of spectroscopically pure mercury by a current of π amperes will emit exactly 8.965×10^{10} electrons per second, the measurements being taken under standard conditions. A renowned professor has determined this length accurately to seventeen decimal places.

The plodding engineer, on the other hand, defines his inch as the distance between the first and second joints of his left forefinger.

° ° °

"Beg your pardon, but aren't you an engineering student?"

"No, it's just that I couldn't find my suspenders this morning, my razor blades were gone, and a bus ran over my hat."



One of a series*

Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas — meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

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